

2022 Report Card for Tennessee's Infrastructure

*Tennessee Section of the
American Society of Civil Engineers*



InfrastructureReportCard.org/Tennessee



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2022 Tennessee Report Card Executive Summary

“Unprecedented” – a description that has been used almost to exhaustion in the past few years. It’s been used to describe COVID, severe weather events, workplace disruptions, and the list goes on. Unprecedented can also be used to describe where we find ourselves with regards to infrastructure. Tennessee, like the rest of the country, is seeing its roads, bridges, drinking water systems and more reach the end of their service lives. However, state action - along with more robust federal support - is coming at a crucial time and allowing us to rehabilitate much of our built environment. And not a moment too soon. We’ve seen what happens when we don’t invest, with closures of the I-40 bridge in Memphis, pipe breaks that prevent water from reaching homes and businesses, and power outages that last days or weeks following unexpected events including extreme weather, or domestic terrorism.

Fortunately, Tennessee has seen progress in some areas thanks in large part to increased funding from passage of state and federal legislation. Since 2016, the last time an Infrastructure Report Card was released for our state, multiple initiatives have been used to make strides in improving many areas of our state’s infrastructure. The increase of the state gas tax has allowed Tennessee to continue as a “Pay as you Go” state, one of only five in our country, while improving the overall condition of our roads and bridges and reducing or eliminating the local match required to fund some projects. Investment into the state’s parks systems included major renovations of lodges and camping areas at some of the state’s most popular destinations. Local utilities continue to provide safe and reliable drinking water with low interest rate loan programs. However, as our state’s population grows at ever increasing rates, use of transit systems is not increasing accordingly, and the additional stress on our solid waste and wastewater systems continues to mount.

Overall, there’s still work to be done. Much of our state’s infrastructure, similar to that across the country, is over 50 years old, and in some cases even older. As our infrastructure continues to age, we can’t afford to sit back and enjoy our progress – additional action is needed. Federal support is now on the way thanks to 2021 federal legislation: the Bipartisan Infrastructure Law, Inflation Reduction Act, and the American Rescue Plan Act. Opportunities abound for funding of infrastructure projects. While these support mechanisms look different for each area of infrastructure, the hope is that these laws allow significant gains to our state’s infrastructure in terms of condition, capacity, and resilience.

The opportunity for unprecedented improvement in our state’s infrastructure is apparent. However, along with being unprecedented, the hope is that it will also be long-lasting and impactful, ultimately improving the lives of the people of Tennessee, the users of the state’s infrastructure. As we look to the future of infrastructure in our state, let’s move from using the word unprecedented to using the word resilient.

About the Report Card for Tennessee's Infrastructure

While you may not think about infrastructure daily, civil engineers do because we have pledged to build it, maintain it, and keep the public safe. As an organization of civil engineers who live and work in Pennsylvania, we want to share what its condition is and what can be done to improve it.

Methodology

The purpose of the Report Card for Tennessee's Infrastructure is to inform the public and decision-makers of the current condition of our state's infrastructure in a concise and easily accessible format of a school report card. Each of the categories of infrastructure covered in the Report Card is assessed using rigorous grading criteria and recent data to provide a comprehensive assessment of the area's infrastructure. ASCE has used the following criteria to discuss and grade the state of the infrastructure:

CAPACITY

Does the infrastructure's capacity meet current and future demands?

CONDITION

What is the infrastructure's existing and near-future physical condition?

FUNDING

What is the current level of funding from all levels of government for the infrastructure category as compared to the estimated funding need?

FUTURE NEED

What is the cost to improve the infrastructure? Will future funding prospects address the need?

OPERATION AND MAINTENANCE

What is the owner's ability to operate and maintain the infrastructure properly? Is the infrastructure in compliance with government regulations?

PUBLIC SAFETY

To what extent is the public's safety jeopardized by the condition of the infrastructure, and what could be the consequences of failure?

RESILIENCE

What is the infrastructure system's capability to prevent or protect against significant multi-hazard threats and incidents? How can it quickly recover and reconstitute critical services with minimum consequences for public safety and health, the economy, and national security?

INNOVATION

What new and innovative techniques, materials, technologies, and delivery methods are being implemented to improve the infrastructure?

Grading Scale

A: EXCEPTIONAL, FIT FOR THE FUTURE

The infrastructure in the system or network is generally in excellent condition, typically new, or recently rehabilitated, and currently meets capacity needs for the future. A few elements show signs of general deterioration that require attention. Facilities meet modern standards for functionality and are resilient to withstand most disasters and severe weather events.

B: GOOD, ADEQUATE FOR NOW

US infrastructure in the system or network is in good to excellent condition; some elements show signs of general deterioration that require attention. A few elements exhibit significant deficiencies. Safe and reliable, with minimal capacity issues and minimal risk.

C: MEDIOCRE, REQUIRES ATTENTION

The infrastructure in the system or network is in fair to good condition. It shows general signs of deterioration and requires attention. Some elements exhibit significant deficiencies in conditions and functionality, with increasing vulnerability to risk.

D: POOR, AT RISK

American infrastructure is in poor to fair condition and mostly below standard, with many elements approaching the end of their service life. A large portion of the system exhibits significant deterioration. Condition and capacity are of serious concern with a strong risk of failure.

F: FAILING/CRITICAL, UNFIT FOR PURPOSE

The infrastructure in the system is in unacceptable condition with widespread advanced signs of deterioration. Many of the components of the system exhibit signs of imminent failure.

2022 Report Card for Tennessee's Infrastructure

Overall Grade: C

- Aviation: C+
- Bridges: B
- Dams: D+
- Drinking Water: C+
- Energy: C+
- Inland Waterways: C
- Public Parks: C+
- Rail: C
- Roads: C
- Solid Waste: C+
- Stormwater: C+
- Transit: D+
- Wastewater: C-

Recommendations to Raise the Grade

Increase availability and acquisition of data used for design, planning, and other decision-making processes.

TN collects a lot of data on transportation-related areas of infrastructure. However, data on other infrastructure networks is limited. Although improvement in this area has been seen specifically in the areas of water & wastewater, there is still limited to no data on locally or privately owned infrastructure components, including stormwater, dams, and parks.

Fully fund infrastructure projects as needed to eliminate backlog and/or deferred maintenance so agencies can better address aging systems in the future.

Although strides have been made across the state to eliminate work backlog and reduce local matches for some projects, there are still areas with large amounts of deferred maintenance.

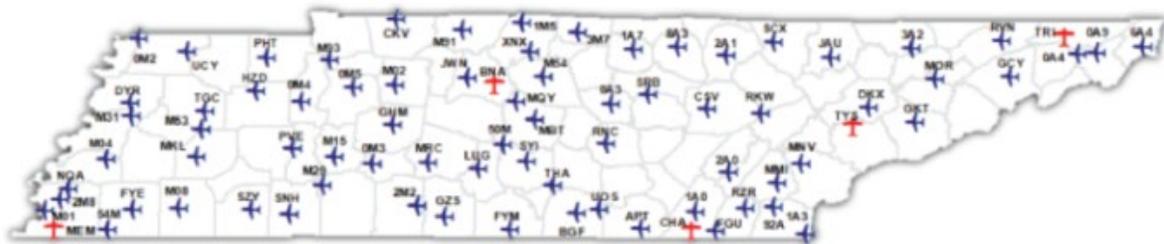
Include considerations for population growth and extreme weather events when planning and funding future projects.

TN has seen heavy increases in both population and the incidence of extreme weather events in the past few years. For our infrastructure to keep up with these changes, special attention must be paid to these trends when planning and funding for future projects.

Aviation: C+

Executive Summary

There are 78 public-use airports in Tennessee: five primary commercial service airports and 72 general aviation airports. Memphis International Airport is a major freight hub and consistently ranks first nationally in the nation by tons landed. The aviation economy accounts for 221,000 jobs, \$13 billion in payroll, and \$40 billion in business revenue in 2019. Paved surfaces are in acceptable condition, with 68% rated as fair or better. Current and future aviation infrastructure in Tennessee is critically harmed by the state legislature’s vote in 2015 to cap aviation fuel taxes, causing an investment gap that widens as the legislation continues lowering the nominal cap amount each year – a sum losing value because of inflation.



Capacity

Aviation infrastructure includes an interconnected network of airports within the Federal Aviation Administration (FAA)-controlled airspace, operated by FAA navigational and communications systems. Capacity of aviation infrastructure is defined by its capability to support safe and efficient operation of aircraft between departure and destination points and on airport facilities.

Tennessee’s aviation infrastructure is comprised of 78 public-use airports serving both commercial and general aviation needs. The network consists of:

- Five primary commercial service airports (Memphis, Nashville, Chattanooga, Knoxville, Tri-Cities),
- One non-primary commercial facility (McKellar-Sipes Regional-Jackson)
- 72 general aviation facilities (eg: Cleveland, Jetport, Sumner County Regional, etc.)

Figure 1. Classification of Tennessee Airports



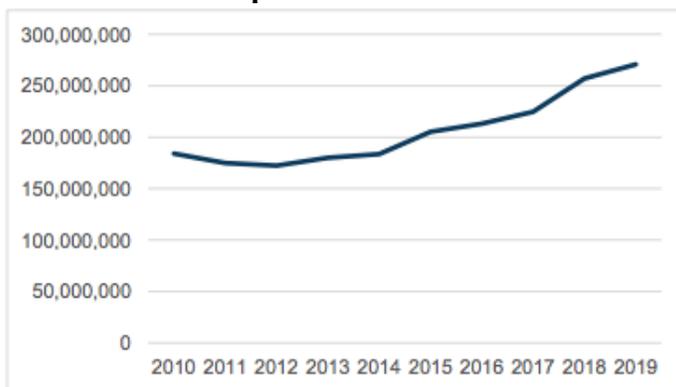
Source: Tennessee Aviation System Plan Executive Summary Final (2021)

The general aviation facilities provide mixed aviation services that support air cargo service, unscheduled passenger operations, medical services, military operations, recreational flying, and a variety of other aviation-related activities. Of the 72 general aviation airports, five are considered reliever airports to the commercial facilities and are designed to ease air traffic congestion and provide general aviation with improved access to the local area. Additionally, Memphis International Airport serves as a super-hub for the world’s largest freight carrier, FedEx Corporation. Consequently, FedEx is Memphis’ largest employer.

Tennessee airports provided services to more than 739 million annual passengers in 2018. According to the Tennessee Vacation Industry, in 2019, almost 126 million visitors came to the state, with an estimated 5.7 million arriving at one of Tennessee’s commercial service airports. Over 884,000 visitors also arrived via one of the state’s general aviation airports. While the state experienced a 55% reduction in enplanements during the COVID-19 pandemic, long-term data indicates a growth path of 8.5% annually (Figure 2). Since 2010, Tennessee’s enplanements have seen tremendous growth, showing a 47% increase from 2010 numbers to total more than 270 million enplanements in 2019. The Chattanooga and Memphis airports specifically experienced years of increased enplanements above 5%, while Knoxville and Nashville have shown consistent increases over a five-year pre-pandemic period. As one of the fastest growing metropolitan areas in the U.S., Nashville International Airport (BNA) experienced over 100 % growth from 2010, with enplanements totaling almost nine million alone in 2019. Nashville’s growth has been fueled by major airlines (such as Southwest) increasing their hub activity at the facility. As a result, Nashville now classifies as a Large Primary Hub, per FAA standards.

Additionally, Memphis is a major freight hub and consistently ranks first annually for number of tons landed at U.S. airports. The facility is anchored by FedEx’s world hub operation, which accounts for a 5% average growth rate over the prior five-year period. By comparison, Memphis accounts for 10% more cargo tonnage than the second-ranked airport in the U.S. (Anchorage), and 50% more than the third-ranked facility (Louisville).

Figure 2. Tennessee Enplanement Growth 2010-2019

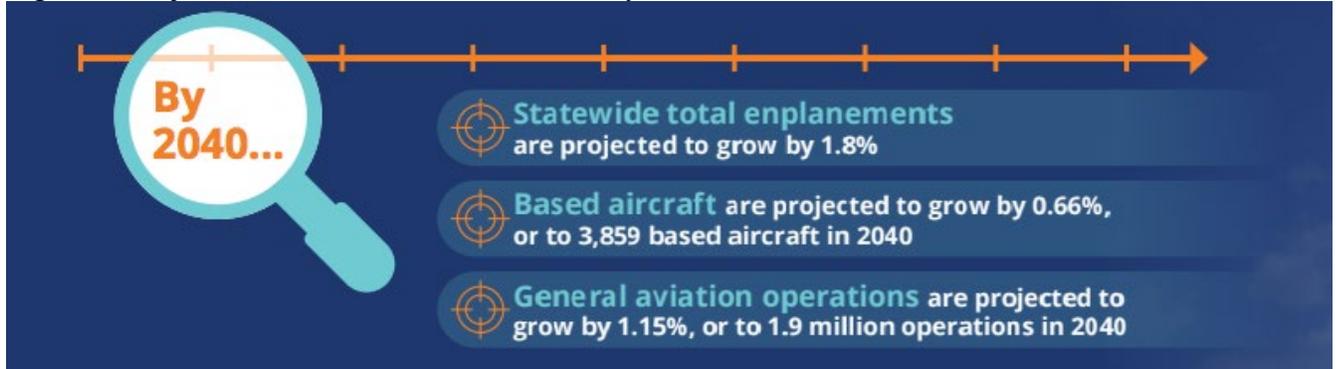


Source: Tennessee Aviation System Plan Aviation System Issues Report 2021)

TDOT recently prepared projections of general aviation activity for Tennessee for five-year (2025), 10- year (2030), and 20-year (2040) periods. Such forecasts help the TDOT Aeronautics

Division understand where future growth for its system will likely occur and what future growth is realistic at airports in the state (Figure 3).

Figure 3. Projections of General Aviation Activity for Tennessee



Source: Tennessee Aviation System Plan Executive Summary Final 2021)

Given the continued increase in travelers through Tennessee's airports, as well as growing cargo tonnage, capacity improvements at Tennessee's airport facilities will be vital to meeting the growing needs. It is suggested that airport land use compatibility practices are helpful tools that can safeguard the airports' capacity to develop in response to growing demands and new markets.

As of July 2022, FAA awarded the Chattanooga Airport with \$5 million to fund phase one of a terminal expansion project to enlarge the airport's second level by almost 27,000 sq. ft, according to the U.S. Department of Transportation (DOT) release. The expansion includes two new gates, one expanded gate, restrooms, and additional passenger queuing space, holding room and circulation space. A smaller, \$475,000 grant will go to the Crossville Memorial Airport in central Tennessee to help bring the terminal building into compliance with the Americans with Disabilities Act (ADA).

New Horizon is the next step in the construction and renovation of Nashville International Airport following BNA Vision, which began in 2017 and will continue through 2023. New Horizon is expected to cost an additional \$1.4 billion and will be phased in over the next six years with a scheduled completion in late 2028. Consistent with all airport capital improvement projects, no local tax dollars will be used. New Horizon funding will come from bonds, federal and state aviation grants, Passenger Facility Charges (PFCs) and other airport funds.

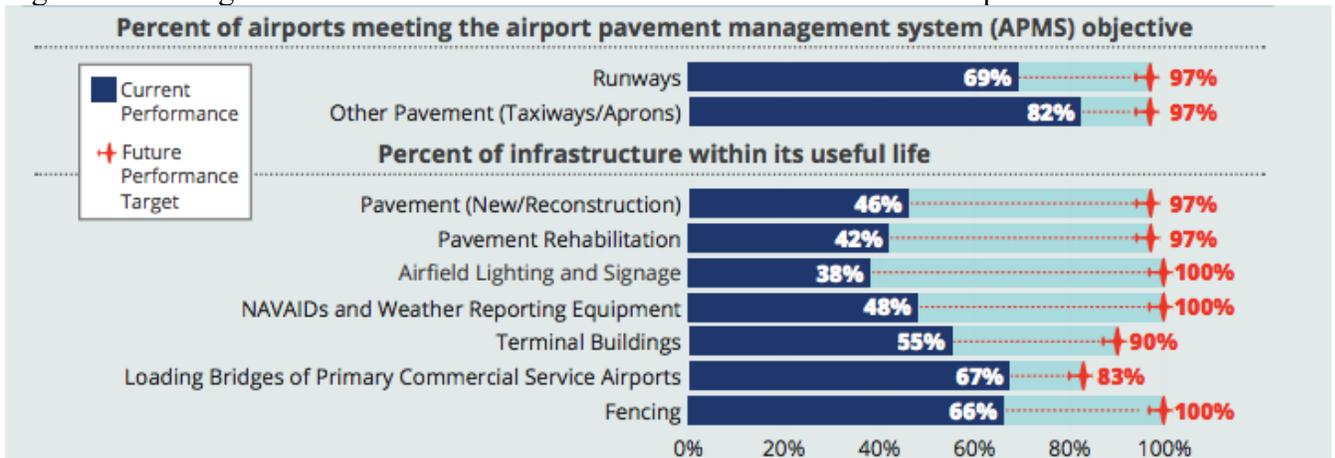
Condition

Given their essential nature, airport pavement surfaces serve as the most prominent indicator of overall airport condition. Beyond pavements, airports are host to a number of facilities such as terminals, hangars, fueling systems, etc. Regular maintenance and repair are necessary to preserve condition these vital infrastructure components.

Overall, 46% of the total amount of pavement that is new or has been reconstructed in Tennessee, is less than 20 years old. These statistics reflect the priority given to the state's most

prominent aviation asset component (Figure 4). However, it must be mentioned that pavement is constantly deteriorating with time and use. Airfield pavement surfaces require regular maintenance and repair to maintain their operability. Without this periodic attention, pavement conditions could deteriorate precipitously to Fair, Poor, Serious and Failed thus affecting airport condition. Through efforts supported by TDOT the goal is to preserve airport infrastructure by prioritizing airport system needs.

Figure 4. Existing and Future Performance of Infrastructure at Tennessee Airport Facilities



Source: Tennessee Aviation System Plan Executive Summary Final 2021

Recently, TDOT Aeronautics Division undertook a comprehensive program to definitively and proactively maintain and rehabilitate airport pavements across the state through the Airfield Pavement and Marking Maintenance Contract (APMMC) funded by the Airport Capital Improvement Plan (ACIP) to conduct activities such as crack and joint repairs, seal coatings, and remarking. A review of fiscal year (FY) 2021 airport projects funded for phase 1 of the APMMC showed that approximately 18 airports had projects related to pavement maintenance totaling \$4.1 million. Consequently, eight airports had pavement-related projects for phase 2 FY 2021 for \$2.8 million and will go across 21 airports for another \$4.1 million for phase 3 FY 2022. Phase 4 of funded projected for 2023 is under preliminary study, where 11 airports are identified for study.

Furthermore, TDOT’s 2019-2020 Statewide Pavement Management Program update provided a summary of pavement inventory area, age, and condition information at the statewide level. Through an assessment of 69 airports based on inspections of the period, there were a total of approximately 75.5 million square feet of pavement at in Tennessee airports with an average age of 17 years, with the exception of those made of Portland cement concrete with an average age of 45 years showing a need for further pavement rehabilitation.

Figure 6. Tennessee Airport Facilities Surface Type and Age

Statewide Area-Weighted Age by Surface Type

Chart Both **Table**

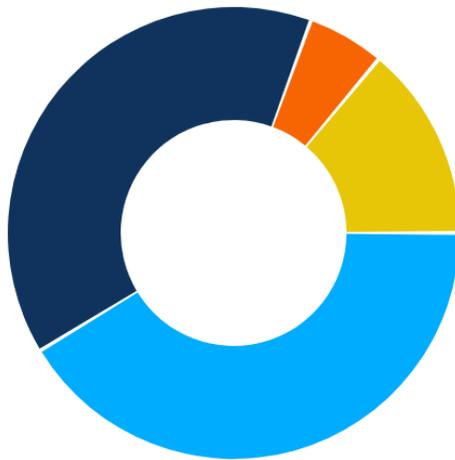
Surface Type	Area-Weighted Age, yrs
● AAC	17
● AC	17
● APC	18
● PCC	45

Statewide Area-Weighted Age by Branch Use

Chart Both **Table**

Branch Use	Area-Weighted Age, yrs
● Runways	17
● Taxiways	20
● Aprons/Helipads	31
● T-hangars	15

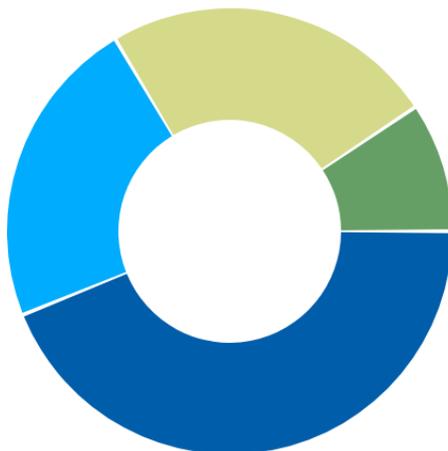
Statewide Pavement Area by Surface Type



By Surface Type (Total Area = 75,535,074 sf)

Surface Type	Area, sf	Percentage
● AAC	31,202,516	41%
● AC	29,643,088	39%
● APC	4,167,255	6%
● PCC	10,522,215	14%

Statewide Pavement Area by Branch Use



By Branch Use (Total Area = 75,535,074 sf)

Branch Use	Area, sf	Percentage
● Runways	33,160,051	44%
● Taxiways	17,024,804	23%
● Aprons/Helipads	18,267,554	24%
● T-hangars	7,082,665	9%

Source: TDOT 2019-2020 Statewide Pavement Management Program Update (Tennessee IDEA)

Additionally, maintenance and preservation of runway, taxiway, and apron pavements represents one of the largest capital investments in the state aviation system. Airport managers reported that

runway and taxiway projects, pavement maintenance, and terminal buildings were the airport infrastructure that represented some of their top concerns, according to the TDOT 2019-2020 pavement report. It further revealed that approximately four airports in Tennessee had projects related to runway design (not rehabilitation), including design for a runway replacements and extensions. Furthermore, 25 airports currently have a full parallel taxiway on the primary runway. Approximately seven airports had projects related in any way to taxiway design, including new taxiway design and rehabilitation design.

Terminal buildings are essential as they facilitate access to air travel for passengers and pilots while also serving as a potential revenue generating facility through vendor leases. Aging terminal infrastructure and terminals which are inadequate to serve increased demand may become costly investments as overstretched and aging facilities may require more maintenance and upkeep to an airport. New terminal buildings or rehabilitation of existing buildings were reported as needs by 23 airport managers by 2020, signaling a significant need for these facilities across the aviation system in Tennessee.

Hangars are enclosed buildings used to store aircraft and protect the significant investments made by owners and operators safely and securely. Hangars shelter aircraft from external elements such as weather, dust, and wildlife, which can impact the longevity of peak aircraft performance. According to 50 of the 78 system airports, insufficient hangar storage remains a top issue to serving airport users across the state. Currently, system airports provide almost 3,000 cumulative conventional box, T-hangar, and shade hangar spaces to users and the airports indicated more are needed to accommodate demand. These needs are projected to become more acute as continued population growth brings new users to the state and projections indicate a shift in the national aircraft fleet over the next 20 years. Furthermore, according to the Tennessee Aviation System Plan (TASP) Inventory Data Survey, 67 system airports indicate having hangar shortages, either requiring more facilities to accommodate projected demand or having no additional facilities to offer current airport users. Currently, 61 airports maintain a waitlist of approximately 800 aircraft across the state, indicating a critical need for additional hangar space to meet current demand. Providing sufficient hangar space across Tennessee is critical to the long-term financial viability of airports across the state. Providing this infrastructure can allow the airports to further support a growing aviation community in Tennessee and increase the airports' fiscal resiliency in the face of market volatility.

Airport infrastructure development is critical to the growth of airports and their ability to accommodate existing and future user demands. Airside, landside, and other airport services will need to be examined to identify gaps between demand and existing facilities, duplication of services, and opportunities for new market growth. Additional studies are warranted to determine if the TDOT Aeronautics Division can provide further support to system airports to meet infrastructure needs across the state.

Operation & Maintenance

Tennessee maintains one of the nation's most comprehensive and well-developed statewide aviation systems. Safe and efficient airport operations rely heavily upon maintaining and extending the useful life of airport infrastructure, such as airfield and landside facilities. As some of the costliest investments an airport can incur, planning for future infrastructure development

and continued maintenance is crucial for an airport to remain economically and operationally viable. Tennessee public-use airports are owned and operated by local governments (city and county) as well as airport authorities. These entities oversee the daily operation and management of their respective facilities, as well as provide future planning and management of facility construction projects. Airport authorities collect and report all required data mandated by FAA and the state. It is the responsibility of TDOT to support the development of airports and aviation in the state. The agency is also authorized to operate state-owned airports and accept federal grant money through the State Block Grant Program. The TDOT Aeronautics Division provides financial and technical assistance to publicly owned airport sponsors and managers for the planning, development, promotion, construction, and operation of public-use airports throughout the state. The Aeronautics Division administers both state and federal funding for ACIP. Additionally, the Aeronautics Division is responsible for the operational safety and efficiency of the state aviation system, providing engineering services, aviation planning studies, airport improvement, and project design consultation services to state airports. Additional division duties include airport safety inspections, airport maintenance, maintaining a statewide airport system plan, promoting aviation education, and providing flight services to all branches of state government.

At the facilities where military operations exist, a joint-use agreement is negotiated between the airport sponsor and the specific military branch of service. These agreements provide proceeds used for operation and maintenance costs and are used as mechanisms for helping develop and fund future facility needs.

In 2015, the TDOT Aeronautics Division developed a statewide pavement management program to assess pavement conditions and analyze needs for pavement restoration and maintenance. Pavements are now inspected and quantified with a pavement condition index (PCI) number ranging from 0 to 100. These indexes are juxtaposed against the minimum service level (MSL) defined by the TDOT Aeronautics Division as the minimum pavement condition yielding a rating of satisfactory. The target values for minimums are as follows: Runway – 65; Taxiway -60; and Apron- 60. The Division is currently working to fund projects for pavement repairs that fall below the minimum service level threshold.

Figure 7. Tennessee Airport Facilities PCI Ratings

Statewide Area-Weighted PCI by Surface Type

Chart Both **Table**

Surface Type	Area-Weighted PCI	Category
 AAC	72	 Preventive Maintenance
 AC	76	 Preventive Maintenance
 APC	57	 Major Rehabilitation
 PCC	73	 Preventive Maintenance
 Overall	73	 Preventive Maintenance

Statewide Area-Weighted PCI by Branch Use

Chart Both **Table**

Branch Use	Area-Weighted PCI	Category
 Runways	73	 Preventive Maintenance
 Taxiways	73	 Preventive Maintenance
 Aprons/Helipads	72	 Preventive Maintenance
 T-hangars	74	 Preventive Maintenance
 Overall	73	 Preventive Maintenance

Statewide Area-Weighted PCI by FAA Classification

Chart Both **Table**

FAA Classification	Area-Weighted PCI	Category
 National	52	 Major Rehabilitation
 Regional	75	 Preventive Maintenance
 Local	75	 Preventive Maintenance
 Basic	79	 Preventive Maintenance
 Unclassified	60	 Major Rehabilitation
 Non-NPIAS	58	 Major Rehabilitation
 Overall	73	 Preventive Maintenance

Statewide Area-Weighted PCI by TASP Classification

Chart Both **Table**

TASP Classification	Area-Weighted PCI	Category
 Commercial Service	68	 Major Rehabilitation
 Community Business	74	 Preventive Maintenance
 Community Service	72	 Preventive Maintenance
 Regional Service	73	 Preventive Maintenance
 Overall	73	 Preventive Maintenance

Source: TDOT 2019-2020 Statewide Pavement Management Program Update (Tennessee IDEA)

Demand on the aviation system is anticipated to grow exponentially in Tennessee and will likely outpace the number of highly qualified and experienced professionals available in the workforce. Despite recent trends in growing certified and student pilot populations, aviation stakeholders at the federal, state, and local levels must work in a collaborative nature to eliminate barriers for new generations from considering a career in aviation. In FY 2020, TDOT Aeronautics Division awarded nearly \$200,000 in grants to schools and organizations which promote student exposure to aviation careers and skill development under its Aviation Education and Outreach Program. Grant awards have been used to purchase equipment such as drones and flight simulation software, create and expand aviation career exploration curriculum at grade schools, and prepare collegiate students for success through increased hands-on experience and FAA-approved program certification. Tennessee system airports can help close the gap between demand and availability of skilled and educated aviation professionals in the field. Currently, 43 airports have some sort of aviation educational program geared towards increasing exposure and opportunities for school-aged students into aviation careers, while 11 airports support an airframe and powerplant program. Supporting an expansion of these programs at system airports can help develop a growing population of new aviation professionals to meet rising demand.

Funding

Funding for airport capital improvement projects, including maintenance and repair of infrastructure, comes primarily from the FAA and TDOT. User taxes and fees, as well as general fund revenue, supports these sources. The statewide economic impact of Tennessee’s airports consists of three major categories: On-Airport Impacts, Visitor Spending Impacts, and Freight/Cargo Impacts. Almost seven million out-of-state visitors traveled through one of the state’s commercial service or general aviation airports, contributing \$9 billion to the state’s economy. The economic impact attributable to on-airport activity accounts for almost \$12 billion. Tennessee’s airports also contribute to the state’s economy with freight/cargo services, which support over 82,000 jobs and \$19 billion in economic impact. Together, they account for \$40 billion in economic impact for Tennessee in 2019.

Commercial airports in Tennessee utilize the FAA’s Passenger Facility Charge (PFC) Program, which allows commercial airports to fund FAA-approved projects that enhance safety, security, or capacity; reduce noise; or increase air carrier competition. These funds are vital to projects which help commercial airports meet future needs and cannot be used for revenue producing projects, such as parking garages or terminal areas leased by specific air carriers. PFCs are capped at \$4.50 per flight segment with a maximum of two PFCs charged on a one-way trip or four PFCs on a round trip, for a maximum of \$18 total. The PFC cap was instituted in 2000 and was not indexed for inflation or growth. This limits local airport’s ability to fund projects that are needed for future expansion, safety, capacity, and innovation. When the PFC user fee is maxed out, airports aren’t able to fund needed infrastructure projects that help the airport keep pace with growth in passenger and cargo volume.

Table 1. Tennessee PFC Approved Locations

Associated City	State	Airport Name	Start Date	Expiration Date	Total PFC Approved (by location)
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Bristol/Johnson/Kingsport	TN	Tri-Cities	7/1/07	10/1/23	18,839,520
Chattanooga	TN	Lovell Field	2/1/05	10/1/22	35,073,749
Jackson	TN	McKellar-Sipes Regional	10/1/02	6/1/25	332,248
Knoxville	TN	McGhee Tyson	10/1/03	10/1/25	92,301,420
Memphis	TN	Memphis International	9/1/18	5/1/29	152,090,128
Nashville	TN	Nashville International	5/1/15	3/1/36	943,703,242

Source: Federal aviation Administration, December 2021

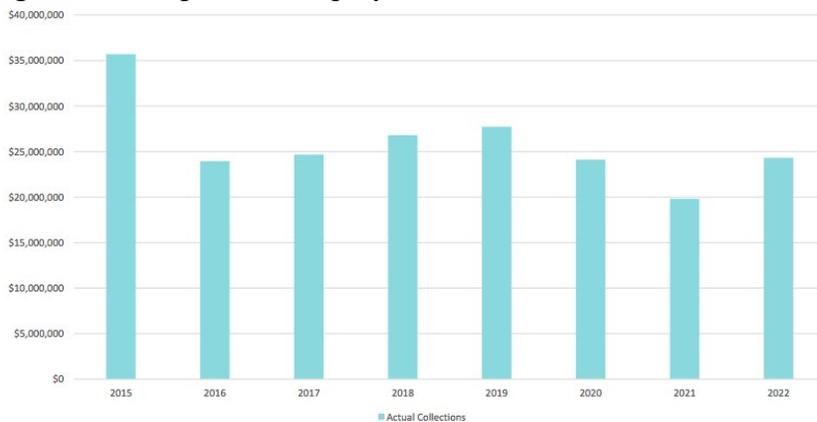
Table 2. Tennessee PFC Maxed-Out Airports

TENNESSEE AIRPORTS	PFC CONSTRAINED UNTIL
Tri-Cities	2019
Nashville International	2020
Lovell Field	2020
McGhee Tyson	2023
McKellar-Sipes Regional	2025
Memphis International	2029

Source: Tennessee Airport Needs, Airport International Council 2019

TDOT Aeronautics Division allocates funding from three major sources: the state Transportation Equity Fund (TEF), federal apportionment, and federal non-primary entitlement (NPE) funds. Maintenance and capital improvements are funded via grants from the Tennessee Transportation Equity Fund (TEF). The TEF utilizes a 4.25% aviation fuel tax as the primary mechanism for generating funding. This tax is included in the fuel purchase price throughout Tennessee’s aviation facilities. The TEF disperses its proceeds between commercial airports and general aviation airports.

Figure 7. Transportation Equity Fund Revenue



Source: TDOT Annual General Aviation Regional Meetings 2022

FedEx, a major employer and economic driver in Tennessee, occasionally expresses interest in relocating to nearby states with better fuel tax rates or special tax exemptions. The Tennessee General Assembly estimates that the loss of FedEx would create a negative economic impact of \$1.4 billion, and the loss of 36,000 jobs from Memphis' largest employer. When FedEx threatened to leave Tennessee in 2014-2015, the legislature passed SB 982, capping the amount of fuel tax that could be collected from a single corporation or individual. Subsequently, The aviation fuel tax rate was lowered from 4.5% to 4.25% in 2021. In addition to the tax decrease, the cap was further reduced from \$10.5 million to \$8.5 million for FY 2021-2022. The cap will again drop to \$5 million in the following tax years.

FedEx is again one of the main beneficiaries of this fuel tax cap; the company's tax bill shrunk from approximately \$32 million in FY 2015 to approximately \$10.5 million in FY 2022, meaning the corporation is paying taxes on just one third of the fuel they're purchasing.

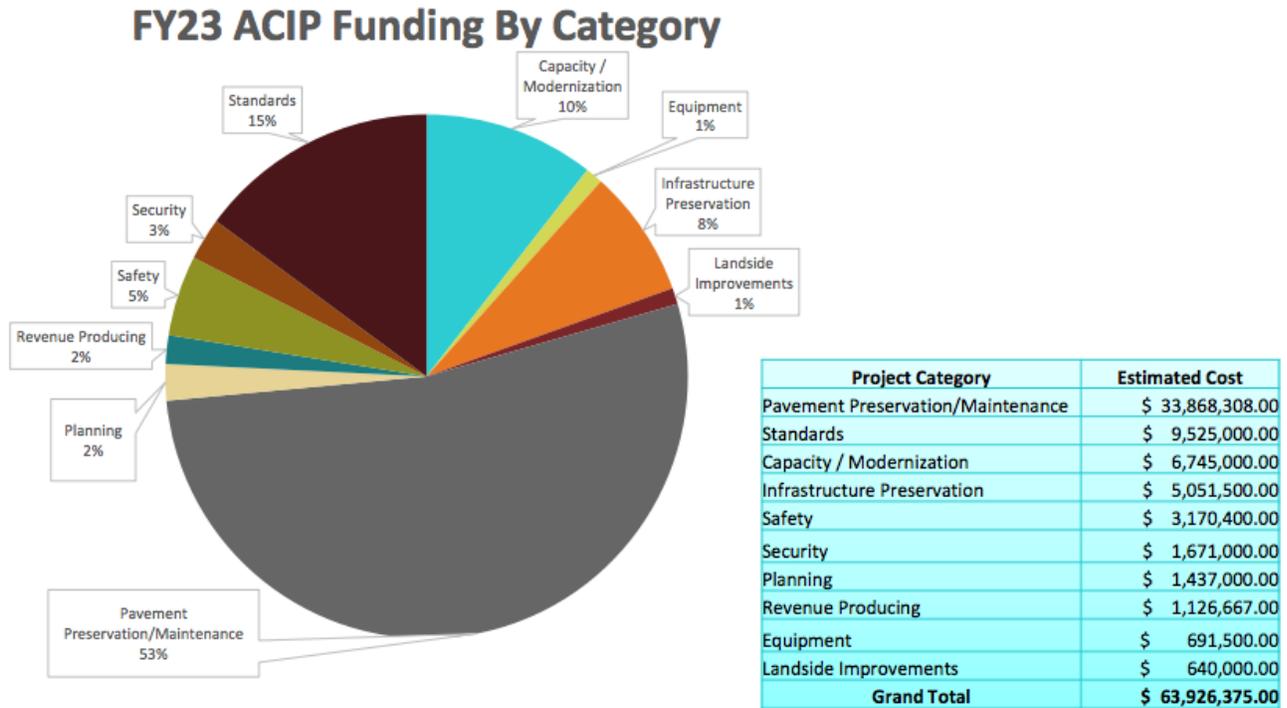
As the single contributor cap continues to decrease, the difference in revenue for airports will need to be backfilled by the state. Funding for the TEF comes the aviation fuel tax and benefits aviation infrastructure planning, construction, development, promotion, and operation of nearly all the airports in the state. Anticipated revenues for TEF will be \$3 million less in FY 2021 and \$6.4 million less in subsequent years. Subsequently, the state will need to provide revenue out of the general fund, thereby depriving other departments and programs with necessary funding. As of now there are no other plans to raise this money.

Aviation infrastructure is also supported with federal grants through the FAA Airport Capital Improvement Plan (ACIP). Tennessee is set to receive \$300 million from the Bipartisan Infrastructure Law administered through FAA to airport development over 2022-2026 for improving runways, taxiways, and airport-owned towers, terminal development projects, and noise reduction projects. In December 2021, FAA announced that it will award an estimated \$59 million to Tennessee's 68 airports from funding made available by the Bipartisan Infrastructure Law to receive annually over the five-year period. ACIP support can require states to match a certain percentage of funds provided. The decline in aviation fuel tax proceeds will directly influence the state's ability to provide the required match to federal funds, which will hamper our ability to fund future projects at the same level as prior years. Consequently, projects that emphasize safety, resiliency, and capacity will need to take priority, and fewer overall improvements to airports will take place. The following commercial airports in Tennessee were estimated to receive funding during the first year of the Bipartisan Infrastructure Law:

- Tri-Cities in Bristol/Johnson/Kingsport: \$2,071,492
- Lovell Field in Chattanooga: \$3,807,762
- McGhee Tyson in Knoxville: \$5,198,165
- Memphis International in Memphis: \$17,290,889
- Nashville International in Nashville: \$17,878,867

Below is a projection for FY 2023 funding for airport capital improvement projects across the state.

Figure 8. Transportation Equity Fund Revenue

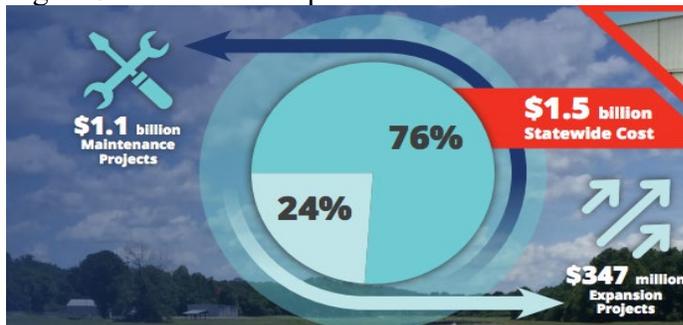


Source: TDOT Annual General Aviation Regional Meetings 2022

Future Need

According to the Airports Council International, infrastructure needs of Tennessee airports from 2019 - 2023 face a funding gap of approximately \$3 billion with a job creation potential of 65,000 jobs. Systemwide cost estimates are based on future system performance and facility and service objectives. Airports that do not meet future performance targets or facility and service objectives are recommended projects to meet targets. Systemwide, the cost of these projects is \$1.5 billion, including \$1.1 billion (76 % of total costs) in maintenance projects and \$347 million (24% of total costs) in expansion projects. Maintenance cost estimates are generally categorized as projects needed to maintain the existing system, while expansion projects are generally defined as new infrastructure or new programs. Total cost estimates shown are for projects resulting from TASP goals and facility and service objectives only. Statewide and commercial service airports' CIPs are not included. Commercial service airports' CIPs alone total over \$2.5 billion.

Figure 9. Tennessee Airport Cost Estimates



Source: Tennessee Aviation System Plan Executive Summary Final 2021

In the years since the aviation fuel tax cap went into effect, funding for state aviation projects has been cut by more than half. This decrease in state funding has greatly impacted airports' abilities to complete necessary projects and compete effectively with airports in other states. The TDOT Aeronautics Division has responded to this issue by simply being unable to fund as many projects as were previously funded. An advisory task force was convened to study the impact of the tax cap, known as the Legislative Aviation Task Force. This task force found that the fully implemented aviation fuel tax cap would result in a \$20 million annual loss of revenue to the TEF. There is currently no redirection of state tax money to make up for the loss in tax revenue that has resulted from the implementation of the aviation fuel tax cap. According to the analysis from UT's Boyd Center for Business and Economic Research, Tennessee's population is expected to grow at a rate of 7.7% from 2020 to 2030, and add 1 million people to the population by 2040, with Nashville serving as the largest growth area.

Innovation

Tennessee's aviation system benefits from two technological advancements commonly known as unmanned aircraft systems (UAS) and the Next Generation Air Transportation System (NextGen). Currently, TDOT Aeronautics Division utilizes UAS to aid in data collection efforts for licensing inspections and has found success in obtaining more accurate surface analyses for the airports as well as monitoring ongoing airport construction projects. TDOT Aeronautics Division provides UAS owners and operators information regarding the safe usage of UAS and when UAS operators should contact airport operators, and maintains a checklist for airport operators to use to begin tracking UAS use requests within five miles from their facilities.

In 2013, the FAA announced its NextGen initiative, which is intended to modernize the outdated U.S. air traffic system. The NextGen system uses digital technologies such as GPS to reduce cancellations, weather delays, taxi and take-off delays, as well as improve safety through better aircraft tracking and communication between air traffic control and pilots.

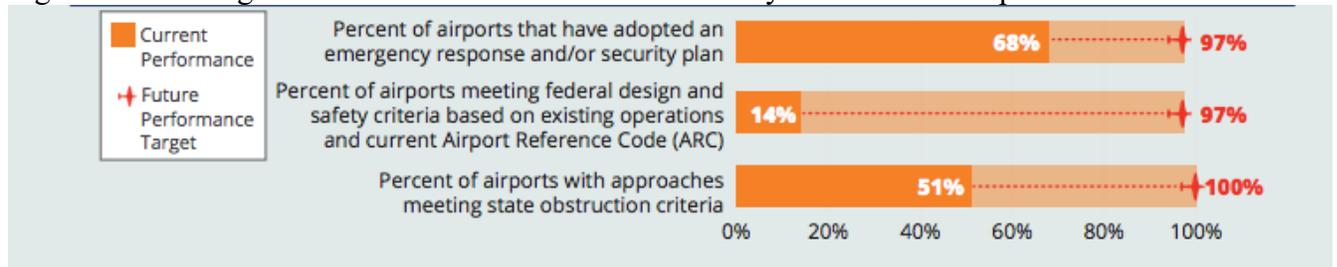
One NextGen technology that will be impacting Tennessee's commercial service airports in the coming years is Terminal Flight Data Manager (TFDM) which is the surface management solution for NextGen. TFDM will alleviate congestion at commercial service airports by making ground aircraft traffic planning more efficient. TFDM capabilities will be implemented incrementally to a subset of National Airspace System Air Traffic Control Towers (ATCTs). Three of Tennessee's airports are projected to receive TFDM capabilities in the coming years, including Nashville International (BNA) in February 2025, Memphis International (MEM) in October 2025, and McGhee Tyson (TYS) in August 2027. More Tennessee airports are encouraged to adopt NextGen practices and infrastructure at their airports to accelerate the process. Airports will need to work in concert with the TDOT Aeronautics Division to determine what key infrastructure and equipment are needed and assess funding priorities to bring these capabilities to their facilities. For airports in which NextGen implementation may result in aircraft delays due to increases in operational efficiency, these airports will need to plan for the development of additional airfield facilities to accommodate growing demand. Runway improvements, facility access, and air traffic control technology will need to be implemented in the near future in order to avoid falling behind our future system needs. Additionally, with the

cap in funding for Aviation Fuel Tax and the uncertain future of the National Aviation System’s governing structure, Tennessee faces a serious dilemma on how these projects can be funded.

Public Safety & Resilience

Many of Tennessee’s airport facilities have been in existence for over 50 years, and most of their roots trace back to simple grass landing strips, which evolved into public-use facilities. As demand has and will continue to increase, these facilities face numerous challenges to meet user needs. In most cases, relocating and establishing a new airport facility to replace an aging facility simply isn’t feasible. Therefore, a continuous investment in our current facilities must exist. This investment is vital in responding to several factors, such as increases in threats to public safety and welfare, passenger travel and services, as well as aircraft size and capability. As always, maintaining public safety is a top priority and protection against loss of life or injury and property damage is held paramount. The general public visiting or using airport facilities must be reminded of the hazards that exist in the airport operating environment and not given access to the active portion of the airfield unless under airport operator supervision. Safeguards to prevent inadvertent entry to the active portions of the airfield and protection from aircraft operating areas/jet blast areas can be provided via fencing, signage, public announcements, and proactive maintenance measures. Special emphasis should be placed in areas of common use, such as parking lots, sidewalks, terminals, and FBO facilities. Routine maintenance tasks, construction, and weather are factors that may lead to additional hazards. Continuous improvement projects are working to sustain the majority of current needs. However, the inevitable decrease in funding threatens the system’s ability to meet future needs.

Figure 10. Existing and Future Performance of Public Safety at Tennessee Airport Facilities



Source: Tennessee Aviation System Plan Executive Summary Final 2021

Recommendations to Raise the Grade

- Address critical funding shortfalls related to aviation fuel tax decreases and single contributor caps.
- Accelerate and increase investment in airport improvement programs, such as the pavement management program, and projects which increase capacity.
- Implement and enhance technology related to FAA’s NextGen initiative, including safety improvements
- Encourage the forecasts of aviation demand indicators, such as enplanements, annual operations, and based aircraft to inform the levels and types of aviation activity projected to occur across the state and shape future policies, studies, and project and funding prioritization to bridge the gap between the existing system and future aviation needs.

- Implement an interest-bearing loan program for airport-related construction projects at publicly owned airports
- Project Priority Process: evaluate the feasibility of implementing a point ranking system for project prioritization based on existing state priorities or a reevaluation of priorities based on system needs.
- Implement an aircraft counting program to forecast and support future TASP facilities and projects

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Bridges: B

Introduction

With over 20,000 bridges within Tennessee, their impact on connectivity, commerce, safety, prosperity and a myriad of other aspects is far-reaching. 43% of bridges in the state are in good condition, 53% are in fair condition, and 4% of bridges are in poor condition. However, locally owned bridges are typically in worse condition than the statewide average. To help with local challenges, the Tennessee legislature decreased the required local match and provided funding in the 2017 IMPROVE Act for 536 local bridge replacement projects. The 2021 Bipartisan Infrastructure Law will provide a 56% increase in available transportation funding over the next five years, which can also help address the local bridge maintenance backlog.

Capacity

A backlog of accumulated and deferred highway needs has occurred due to shortfalls in federal and state funding resources. The result has been an increasing backlog of bridge repair/replacement projects.

Level of service (LOS) is a qualitative measure used to relate the quality of traffic service. LOS is used to analyze highways by categorizing traffic flow and assigning quality levels of traffic based on performance measures like speed, density, etc., and is classified using letters A through F, with A being the best and F being the worst.

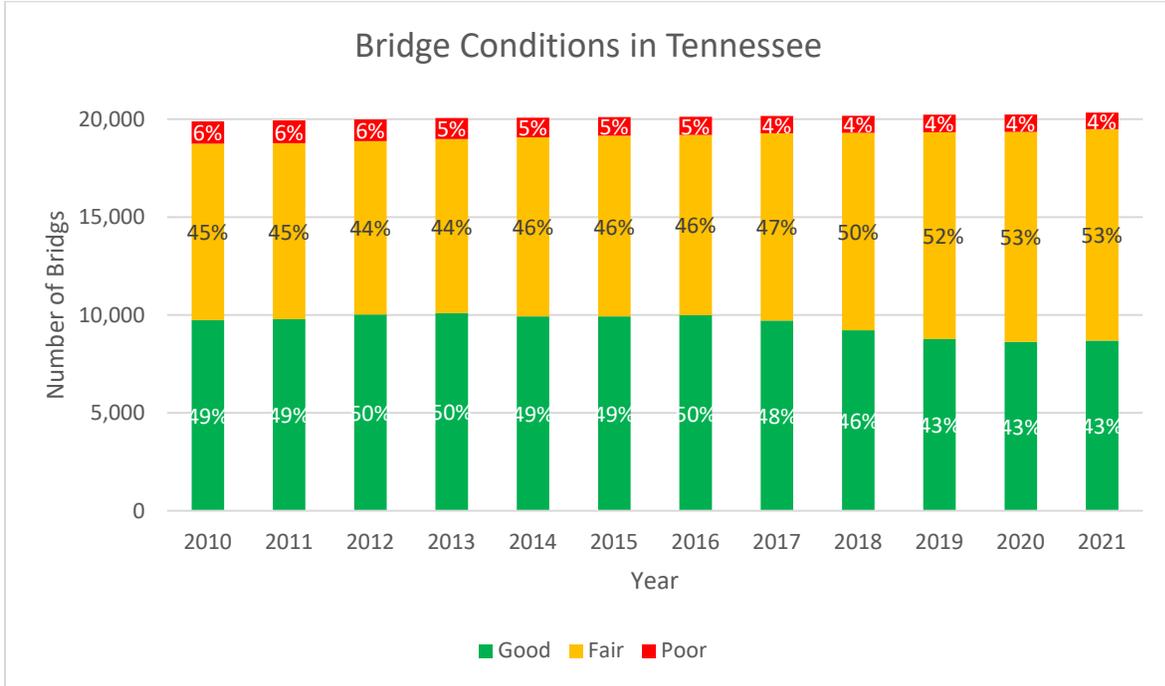
Bridges are segments within a roadway network. The capacity component of a bridge is typically associated with the approaching roadway to that structure. Current data show that 17% of all bridges on state routes and interstates in Tennessee have a LOS of D or worse. The LOS suffers when infrastructure does not keep up with population increases and associated increased congestion. With this condition, average speeds are reduced, and drivers experience delays. Projections nearly 20 years into the future indicate that, by the year 2040, this number rises to 33% - a significant increase in traffic congestion.

Condition

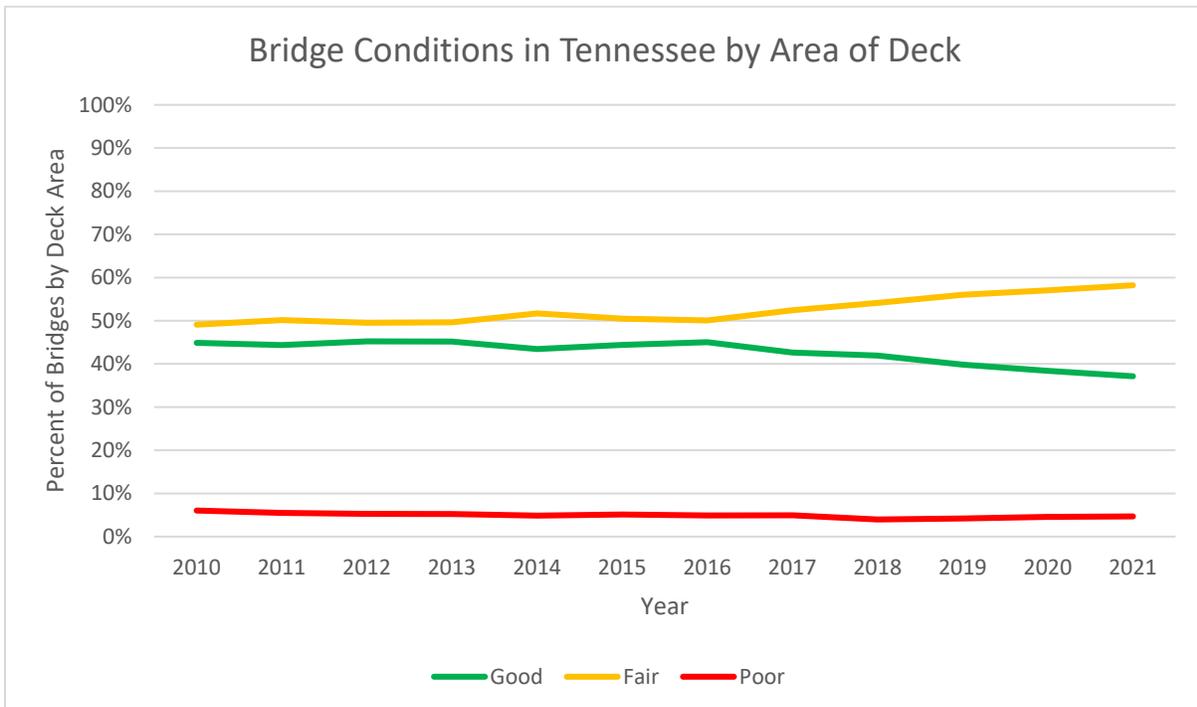
Data current to March 2022 shows that Tennessee had a total of 20,331 bridges on public roads with a length greater than 20 feet owned by any agency. Of those bridges, 8,687 (~42.7%) were in good condition; 10,802 (~53.1%) were found to be in fair condition; and 842 (~4%) bridges were considered in poor condition. Tennessee compares favorably to national averages, where 7.5% of bridges are considered in poor condition.

The graph below shows the history of Tennessee's bridges based on their conditions as evaluated by on-site inspections. As seen in the data, the percentage of bridges considered in "poor" condition has steadily decreased over the past dozen years from 6% in 2010 to 4.2% in 2021. A potentially troubling trend is that there has been an increase in the percentage of bridges in "fair" condition as the number of bridges in "good" condition has decreased. This trend is also evident when evaluating the bridge conditions by the area of bridge deck.

When comparison numbers were last available (2021), Tennessee had the fifth lowest percentage of “poor” bridges of all the Southeastern United States. Additionally, Tennessee ranked #11 (Nationwide) in terms of states with the lowest percentage of bridges in “poor” condition.



Tennessee’s Bridge Conditions, 2010 through 2021 by number of bridges.



Tennessee’s Bridge Conditions, 2010 through 2021, by area of bridge deck.

Funding

Highway bridges are typically financed by a mix of federal, state, and local funding, depending upon the specific nature of the project and the ownership of the bridge. In an effort to continue to provide and support improvements to the state's highway infrastructure, Tennessee has supplemented federal bridge funds with state funds. In April 2017, the Tennessee General Assembly passed the IMPROVE Act -- Improving Manufacturing, Public Roads and Opportunities for a Vibrant Economy. The bill, which raised the state fuel tax, is a user-based approach that provides critical funding for the state's transportation network, including bridges. For FY 2017-18, IMPROVE Act funding allowed TDOT to allocate approximately \$55 million for repairs to bridges on the state highway system, with an additional \$9.5 million allocated for the State Aid Bridge Grant Program to assist local bridge owners with replacement and rehabilitation projects.

The most recent federal legislation to fund transportation, the Infrastructure Investment and Jobs Act (IIJA), was signed into law in November 2021. It allots \$110 billion of new funding for roads, bridges, and major projects, and reauthorizes the surface transportation program for the next five years. Of this amount, \$5.5 billion is to be set aside for a bridge replacement, rehabilitation, preservation, protection, and construction program (to be called the Bridge Formula Program (BFP)). Tennessee is to receive in excess of \$300 million from this funding to repair, upgrade, protect and construct bridges across the state. The state and localities may also compete for competitive grant funding available through other programs in the IIJA.

This legislation increases surface transportation funding by over 56% over five years (FY 2022 - FY 2026). In comparison, the previous transportation law, the Fixing America's Surface Transportation (FAST) Act, provided \$305 billion over five years (FY 2016 - FY 2020).

Tennessee has traditionally been considered as a "pay as you go state" - one of only five states that funds transportation projects without taking on debt. Averse to debt for transportation spending, the federal funding will only go as far as the state can match. However, Tennessee typically maximizes the federal dollars and federal investment in Tennessee has supported \$1.5 billion for capital improvements on more than 1,000 bridge projects between 2011 and 2021.

The new funding levels and revenue streams are not only able to maintain the status quo, but they should allow for overall system improvement over the next decade. With an aging infrastructure, this is an opportunity to slow or even reverse the deterioration trends seen over the last decade.

Tennessee currently budgets approximately \$150 million specifically for its bridge program. The majority of these dollars are allotted to bridge repair, and replacement. The condition of state-owned bridges has been holding steady over time. Local bridges have shown a downward condition trend. To help with local funding challenges, Tennessee passed legislation that decreased the required local match for the State Aid Program from 20% to 2%. Additionally, 536 local bridge replacement projects are in development as part of the 2017 IMPROVE Act passed by the state legislature. These specific projects are to be funded with no match requirement. The IIJA funding also dedicates a minimum of 15% of certain federal bridge funds to be allocated for local bridge projects with no local match requirement.

Future Need

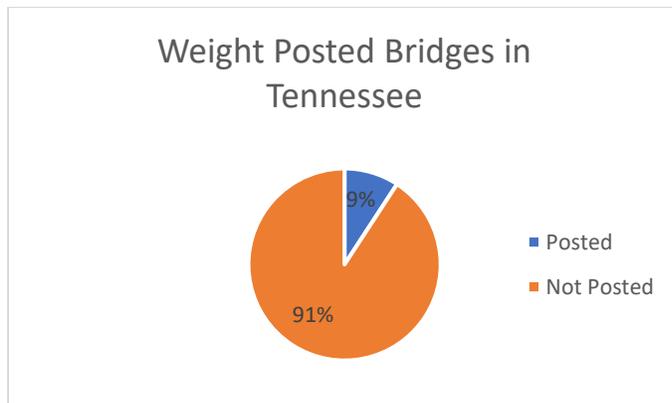
The Tennessee Department of Transportation (TDOT) strives to make the most out of its funding resources. Current data shows that its administrative and operation costs are only 2% of the annual department budget. TDOT also prioritizes maintaining infrastructure assets in a “State of Good Repair” ahead of projects that add to the roadway network. This philosophy has resulted in Tennessee being recognized as one of the Top 10 DOT’s in the nation by the Reason Foundation.

With the influx of new funding sources, it is anticipated that TDOT will be able to address more bridge needs – both state and locally owned. TDOT used many matrix criteria in their bridge management program to identify projects including structure size, age and condition, traffic, and importance. These factors are weighted, and projects are developed on state assets and in cooperation with local government.

Operation and Maintenance

TDOT’s Structure Inventory and Appraisal (SI&A) office is primarily concerned with the safety and condition of the bridges in Tennessee. The SI&A office maintains a complete inventory of bridges and updates them with each inspection. The actual inspections are carried out by TDOT regional inspection teams spread throughout the state. The information gathered in these inspections is used to manage bridge assets, including programming state-owned bridges for replacement or repair. The inspection report information is also submitted annually to the Federal Highway Administration (FHWA) to help determine national highway funds needed for Tennessee.

The inspection and bridge evaluation data is used to assess the need to post restrictive loading on bridges and, in some cases - when the public’s safety is in question, close the structure. This information is shared with the bridge owner on a regular basis and the inspection teams share additional information with the bridge owners to assist in addressing minor needs that can be addressed to preserve the life of the structure. As of March 2022, 1,864 bridges within the state (approximately 9% of the total inventory) are posted to limit the loading legally allowed to cross them. This number drops to around 5% when considering bridges that affect legal (not special permitted) loads.



Weight Restricted Tennessee Bridges (March 2022).

TDOT's Bridge Repair Section is charged with the task of correcting structural deficiencies, vehicular collision damage, concrete or steel deterioration, and streambed scour problems on all state-maintained bridges. To maximize the efficiency of funding, TDOT's Bridge Repair Section strives to operate through the lens of "bridge preservation," going beyond simply addressing immediate needs. The work is carried out by TDOT in-house staff and consulting firms, which are under contract with the Department. These repair projects are let to contract through the normal bid process and administered by the Regional Construction Office. During the actual construction, the Repair Section staff will assist the Regional Construction Office in construction inspection and in solving problems that develop.

Since 2014, over 750 new bridges have been constructed in the state; hundreds have undergone major reconstruction. While funding for preservation and rehabilitation for state-owned bridges has been stable, the dollars available for locally owned bridges does not keep up with the documented need.

Public Safety

Public safety is paramount. Bridge deficiencies can pose major inconveniences and safety hazards to the general public. It is important to note that bridges in "poor" condition do not necessarily pose imminent risk to travelers. They do, however, require investment to avoid becoming hazardous or to avoid restrictions on the weight or speed of vehicles crossing. Weight restricting of bridges can force safety and emergency vehicles to take lengthy detours. Substandard lane and shoulder widths cause increased congestion and accidents. Insufficient vertical and horizontal clearances can cause vehicles to take detour routes and can cause vehicle collisions with bridges. TDOT works to maintain vital freight corridors with unrestricted postings for most of these major routes. When an issue is discovered with a structure on a primary route, the Department verifies that a suitable route is in place to detour freight traffic and repairs are expedited to return the main route back in service.

Resilience

TDOT has contingency plans in place for seismic and flooding events. Cloud-based, geographical referenced software is in place that provide real time notifications to the bridge owner and TDOT when the event reached a defined threshold at vulnerable bridge sites. Additionally, FHWA and the National Highway Institute (NHI) have developed training for emergency response that is available to DOT's. The goal of these efforts is to have a coordinated effort between various state and local agencies in place, with federal support as needed, that can be activated when an event occurs.

Innovation

TDOT has completed numerous accelerated bridge construction (ABC) projects with other projects in the planning phase. In addition to the traditional design-bid-build method, in the last few years TDOT has also employed innovative project delivery methods including Design-Build and Construction Manager/General Contractor (CMGC). These tools have allowed TDOT to deliver many bridge projects quickly with minimal impact to the traveling projects. TDOT has

been able to deliver over a dozen mainline interstate bridge replacement projects with only a 58-hour weekend closure window that minimizes impact to weekday commuter traffic.

To help further the materials and products side of innovation, TDOT sponsors research with universities. Recent examples included low permeability concrete for improved durability of bridge decks, use of thin bonded concrete overlays for bridge decks, pipe pile durability studies and new installation techniques for approach slabs to minimize or eliminate bumps at bridge ends.

Recommendations to Raise the Grade

- Maintain / increase annual investment levels for transportation funding, specifically bridge repair, preservation, and rehabilitation.
- Maintain / increase focus on bridge preservation including outreach to local agencies.
- Continued focus on addressing and reducing the number of bridges in “poor” condition.
- Continued support of research, technology, and initiatives to develop more resilient bridges.

Data Sources and References

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- [https://fox17.com/news/local/tennessee-to-receive-302-million-from-department-of-transportation-bridge-investment#:~:text=\(WZTV\)%20%E2%80%94%20Tennessee%20will%20soon,President%20Biden's%20Bipartisan%20Infrastructure%20Law.](https://fox17.com/news/local/tennessee-to-receive-302-million-from-department-of-transportation-bridge-investment#:~:text=(WZTV)%20%E2%80%94%20Tennessee%20will%20soon,President%20Biden's%20Bipartisan%20Infrastructure%20Law.)
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- <https://www.fhwa.dot.gov/legsregs/directives/orders/19102c.cfm#:~:text=The%20recommended%20training%20frequency%20is,sessions%20on%20an%20alternating%20basis.>

Dams: D+

Executive Summary

Tennessee is home to 1,238 dams for a variety of purposes: drinking water, flood control, recreation, and more. Most Tennessee’s dams – approximately 67% – are privately owned. Unless these privately-owned dams are large enough to be classified as “high-hazard,” potentially causing loss of life and property damage in failure, not much is known about their condition and maintenance practices. Of the 148 state-regulated high-hazard potential dams (HHP), 85% are in satisfactory condition. While all state regulated HHP dams have emergency action plans, just 46% of all HHP dams in the state can say the same. While some funding is allocated for dam repairs through federal funding from the 2021 Bipartisan Infrastructure Law, state-regulated dams still lack adequate budgets and staff to carry out critical dam inspections.

Condition

Dams are an integral part of life to many Tennesseans. There are 1,238 dams in TN, and the average age is about 53 years- which is below the national average of 57 years. However, 205 (16.47%) dams were built in 1950 or earlier. About 95% of the structures are earth dams, 3.5% concrete dams, and the remaining 1.5% are gravity, masonry arch, and rockfill.

As in most places across the country, dams in Tennessee are used for a variety of purposes, including hydropower generation, drinking water, flood control, and small agricultural and recreational facilities.

Out of 1,238 dams identified in National Inventory of Dams (NID), 67% dams are owned by private, non-federal or utility entities, while 7% dams are owned by federal agencies. The remaining 12% and 14% dams are owned by the state and local and utility agencies (Figure 1). Over 274 dams in the state are considered high hazard dams, of which 148 are state regulated with an Emergency Action Plan (EAP). Of the governmental or utility agencies, the three largest entities that own/operate/regulate a majority of the dams in Tennessee are Tennessee Department of Environment and Conservation (TDEC), Tennessee Valley Authority (TVA), and the United States Army Corps of Engineers (USACE). TVA which regulates a system of 49 reservoirs spanning seven states, maintains EAPs for dams throughout the Tennessee River System.

Tennessee dams mostly rely on the state dam safety program for overall assessment. The state dam safety program has the primary responsibility to issue permits, inspect the performance of existing dams, and work with local agencies and private dam owners on emergency preparedness. Tennessee state dam safety officials are experts and are dedicated to ensuring public safety.

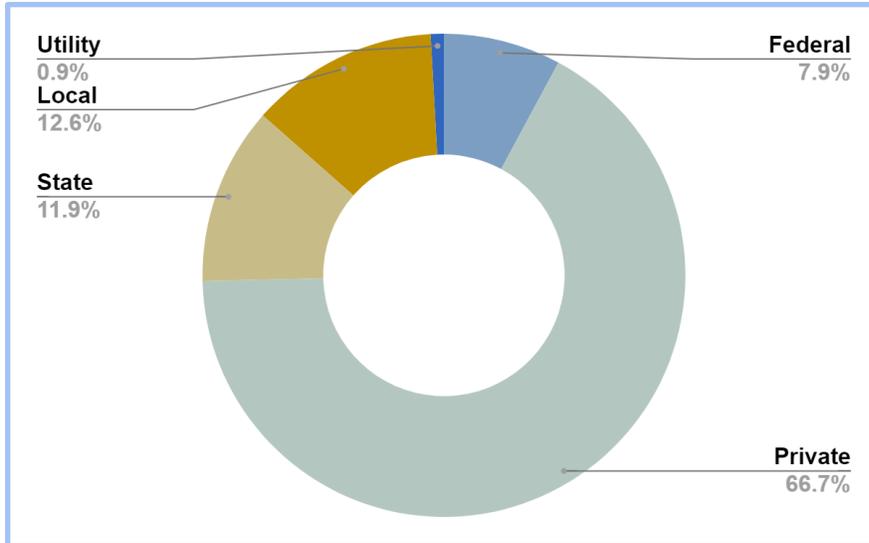


Figure 1. TN Dam Ownership Distribution

The U.S. Army Corps of Engineers’ National Inventory of Dams sorts dams into various risk categories.

- A “High-hazard potential dam” (HHP) is one whose failure or mis-operation will cause loss of human life and significant property destruction.
- A “Significant hazard potential dam” (SHP) is typically defined as a dam whose failure or mis-operation will cause significant property destruction.
- A “Low-hazard potential dam” (LHP) is defined as a dam whose failure or mis-operation will cause minimal property destruction.

As of 2022, out of 1,238 dams in Tennessee identified in the NID, 274 are considered HHP, and 126 of them are privately owned. 356 dams fall in SHP, of which 291 are privately owned, and 608 dams fall in LHP categories, with 438 privately owned (Figure 2).

The state regulates 636 of all Tennessee dams, with 148 dams considered HHP. According to the Dam Safety Performance Report, 85% of state-regulated HHP dams were rated for their current conditions and received a satisfactory rating, meaning – no existing or potential dam safety deficiencies are recognized (Figure 3, 4) (ASDSO, 2018). Of the dams that are regulated by the Tennessee Safe Dams program, HHP dams are inspected annually, SHP dams are inspected every two years, and LHP dams are inspected every three years.

There are 609 dams not regulated by the state, of which 495 are privately owned (about 40% in state’s dams listed in the NID in Tennessee that are exempt and are not rated. According to the NID database, several are rated as low-hazard potential dams. It is unknown how the non-state regulated dams’ conditions and/or statuses are reported. It is also believed that the dams with an unknown primary purpose are mostly farm ponds and are exempt from Tennessee dam regulations and inspections. Farm ponds are defined as *“any impoundment used only for providing water for agriculture and domestic purposes such as livestock and poultry watering, irrigation of crops, recreation, and conservation, for the owner or occupant of the farm, his family, and invited guests, but does not include any impoundment for which the water, or*

privileges or products of the water, are available to the general public." A farm pond is exempt from the Safe Dams Act, but may NOT be exempt from other permitting requirements such as ARAP, etc. (ASDSO, 2018).

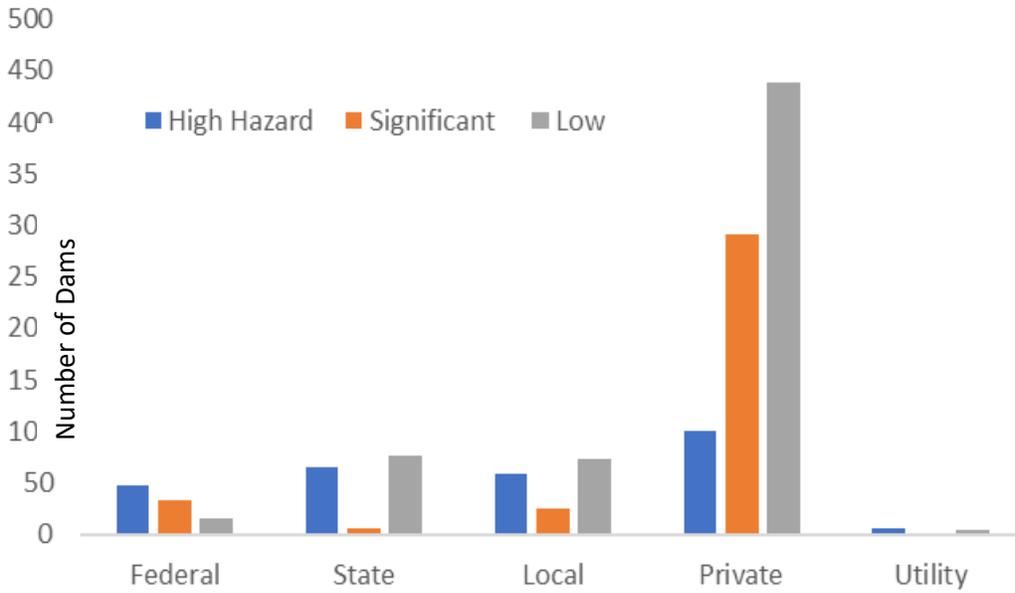


Figure 2. TN Dams Ownership with respect to Hazard Rating

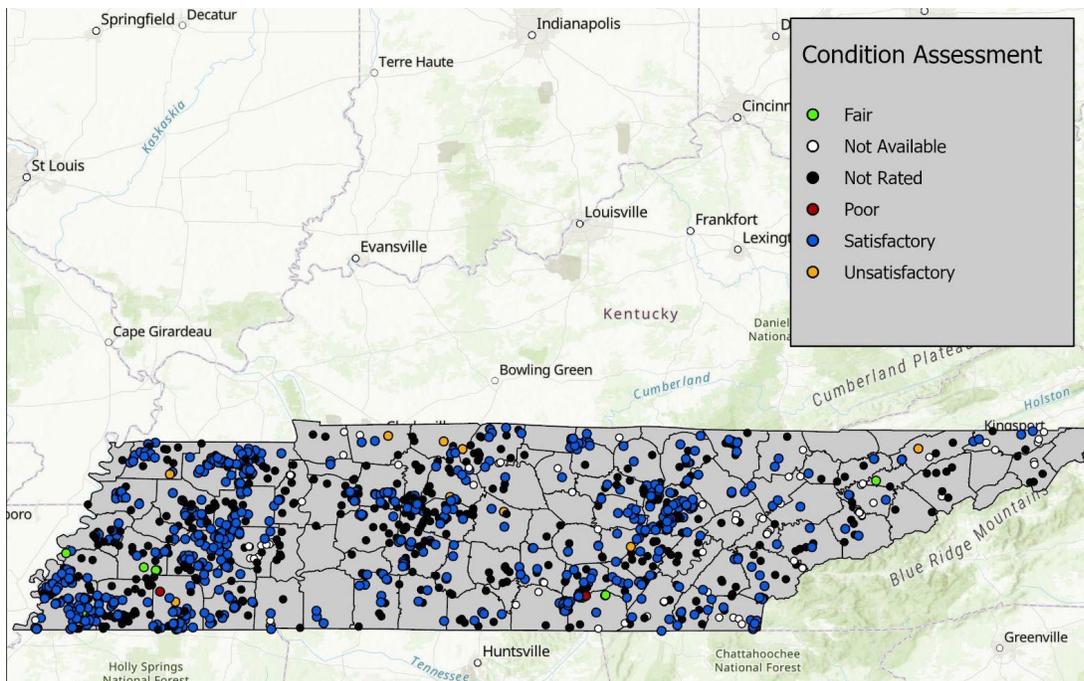


Figure 3. Spatial Distribution of TN Dams Condition Assessment

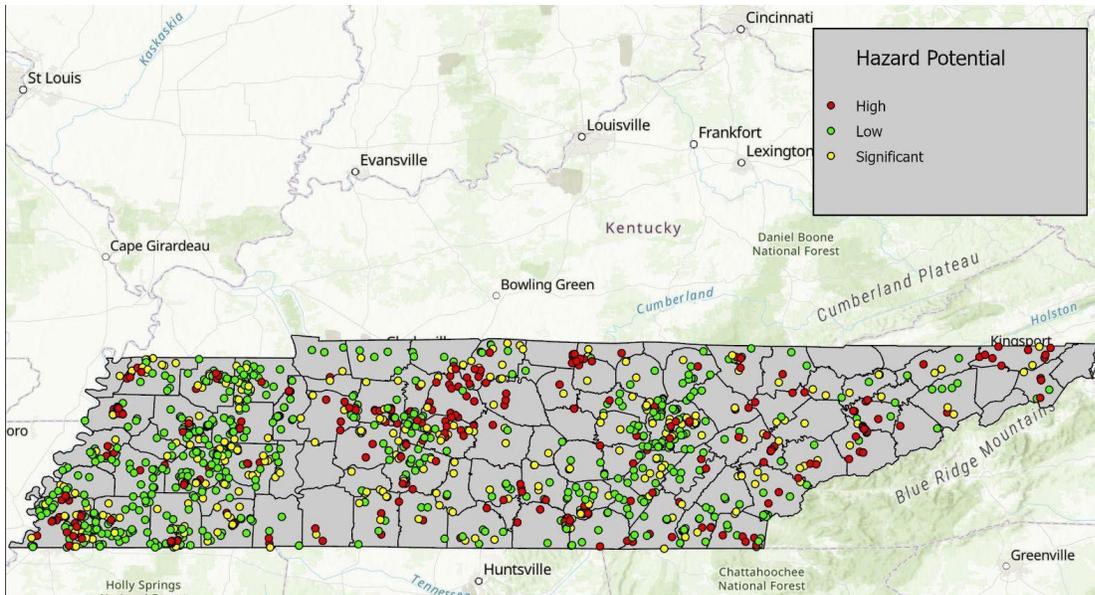


Figure 4. TN Dams Hazard Potential Spatial Distribution

Capacity

Figure 5 is a snapshot of Tennessee dams categorized by their primary purpose. It should be noted that 216 (17%) dams are used for flood control and 190 (15%) are used for recreational purposes. 582 (47%) dams did not have an entry for ‘purpose’ in the NID, which possibly include several privately-owned dams.

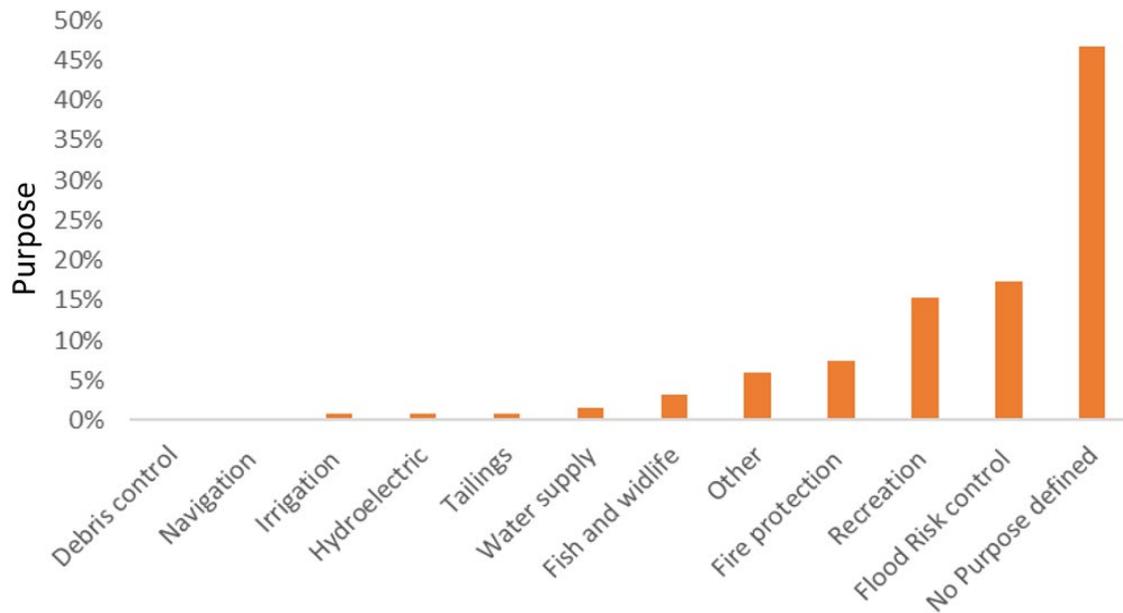


Figure 5. Tennessee dams categorized by their primary purpose.

The average storage capacity of dams within Tennessee is wide ranging with most ranging between 60% and 80% capacity when comparing maximum and normal storage. The arch type

dams are closest to reaching its fill capacity, next is gravity, then earth/gravity. Earth, rock, and concrete dam types are all similar in at around 50-60% fill capacity.

Funding and Future Needs

According to the National Inventory of Dams, 89 of the 1,238 dams in Tennessee receive federal funding. Several of the dams owned, operated or regulated at the federal level do not receive federal funding, however. These 26 dams are owned, operated, or regulated by the US Forest Service, the Mine Safety and Health Administration, Federal Energy Regulatory Commission, and the Fish and Wildlife Service (Figure 6).

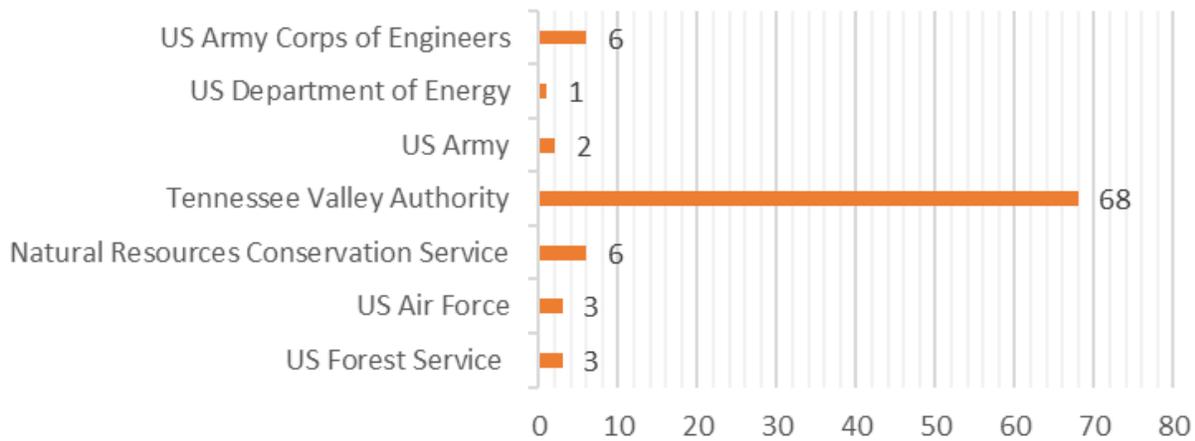


Figure 6. Federal Funding for TN Dams

The National Dam Safety Program (NDSP) is a national program that targets the improvement of dams and the safety of those who live in surrounding communities. The primary purpose of the National Dam Safety Program (NDSP) is to provide financial assistance to the states for strengthening their dam safety programs. The states use NDSP funds for dam safety training for state personnel, increase in the number of dam inspections, increase in the submittal and testing of Emergency Action Plans, more timely review and issuance of permits, improved coordination with state emergency preparedness officials, identification of dams to be repaired or removed, conduct dam safety awareness workshops and creation of dam safety videos and other outreach materials. The current Safe Dams annual budget is about is \$368,000, so the budget per regulated dam is \$568/dam, or the budget for state regulated HHP dam is \$2486/dam. There are significant other funding sources discussed below. This budget stayed steady from 2010. The annual budget is comparable with the average state budget for each state. There are some limited funding available for dams from the federal government through FEMA and Water Infrastructure Finance and Innovation Act (WIFIA).

The state is anticipated to receive funds for improvements and repairs to specific dams like Center Hill Lake, Cordell Hull Dam & Reservoir, Dale Hollow Lake, etc supported by federal funding from the Infrastructure Investment and Jobs Act of 2021 (OCLC, 2022). The official 2021-2022 fiscal year budget for the state of Tennessee sets aside funds for statewide dam repairs, mostly for the dams at Fall Creek Falls, South Cumberland State Parks, West Tennessee River Basin Authority Maintenance, and Division of Water Resources, which regulates most

dams across the state of Tennessee (State of Tennessee Fiscal Year 2021-2022 budget, 2021). These additional funds seem to be non-recurring funding allocations for specific dams.

Operation and Maintenance

The average inspection frequency of federal, state, and local dams are 1 to 3 years, and 4 or more years for private dams.

The government and utility agencies have adequate O&M programs for their respective facilities. Most of the state-regulated, HHP private dams have a satisfactory condition rating, and it can be assumed that they also have a sufficient O&M program. However, about 47% of dams in Tennessee are unregulated – including all farm pond dams – and nearly nothing is known about their O&M programs.

Public Safety

Should a dam fail, other infrastructure such as bridges, roads, and water systems can be negatively affected, in turn putting the public at risk.

46% of all HHP dams have an Emergency Action Plan (EAP) for potential dam breaks that should be followed to minimize property damage and loss of life, and are initiated in the event of dam failure or uncontrolled releases of water. Regardless of state or federal regulatory requirements, all high hazard potential dams should have EAP. It should be noted that the State of Tennessee has an EAP for all 148 state regulated HHP (100%) dams that contain all the elements from FEMA-64 “Federal Guidelines for Dam Safety: Emergency Action Planning” (ASDSO, 2018).

It is essential to have adequate staffing for state dam safety program performance. The state-regulated HHP dams per Full-Time Equivalent (FTE) staff is around 20%, lower than the national average of 28.6% (ASDSO, 2018). The lower than national value is a strong indicator of the need for additional staff resources.

Resilience

A resilient community should have the ability to recognize the benefits of a dam, and anticipate and minimize potential risks from a failure. There are some good resources for public safety around dams like boating and water safety (TVA, accessed 2022). Additionally, TVA recently published a Climate Action Adaptation and Resiliency Plan (2021) to help in carrying out the climate adaptation and resilience management activities and work with stakeholders to identify issues and opportunities that will help create a sustainable, resilient and reliable clean energy future.

Innovation

Most dam innovation is rooted in preparedness, risk assessment, failure prevention. However the US Department of Energy has funded new more efficient hydropower research and development projects as part of renewable energy plans.

In Kentucky the Kentucky Department of Water recently published their findings in testing low cost flood sensors in hopes of establishing an early dam warning system which “will include a

single dashboard that allows users with various agencies to view current and historical water levels at the monitored dams in Kentucky. In addition, the users may subscribe to alerts when water levels reach a certain threshold or water level change is detected that surpasses a given rate”. While the project did not find an adequate implementation method yet they are working towards another grant. If such a program were implemented well in Tennessee it could lower costs while offering a cache of data and early warning alerts (Kentucky Dam Safety Project, 2018).

Recommendations to raise the grade

Tennessee law exempts farm ponds from privately-owned inspection and is not open to the public, regardless of size or hazard potential category. Tennessee ASCE believes that all dams, regardless of their purpose or owner type, present a potential hazard to people and property downstream, and they must be designed, operated, and maintained to accepted standards.

- Condition assessment of all dams by 2030 irrespective of their ownership. Special attention to be taken for privately owned dams.
- Public Education and dissemination of Emergency Action Plan for all high hazard-potential dams.
- Increase state funding for dam safety programs, including adequate staffing of state dam safety offices.
- Ensure that adequate data on dams are available to the policymakers to facilitate decision-making on funding and to the general public to promote public awareness.

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Drinking Water: C+

SUMMARY

The reliability of safe and plentiful drinking water is critical to Tennessee’s communities. EPA's 6th Drinking Water Infrastructure Needs Survey and Assessment (2020) shows that \$8.7 billion is needed to maintain and improve Tennessee’s drinking water infrastructure over the next 20 years. Tennessee’s share of the 2021 American Rescue Plan Act has started to flow through to utilities and more drinking water infrastructure projects are being implemented across the state. 43 utilities report struggling with treated water loss rates north of 40%, a costly occurrence. Overall, however, increases in investment and an exemplary public safety record suggests improving drinking water infrastructure conditions across the state.

CONDITION & CAPACITY

According to the United States Geological Survey (USGS), public utilities across Tennessee supplied approximately 600 million gallons a day (MGD) of surface water, and 250 MGD of groundwater in 2015. Another 43 MGD of groundwater was provided by private domestic wells. The data indicated that over 3.7 million of the state’s population was served by surface water, and over 2.8 million of the state’s population was served by groundwater. Based on data from the Tennessee State Data Center, Tennessee “could grow by nearly a million people over the next 20 years and reach a total population of 7.87 million by 2040.”

With respect to the future of water availability and capacity to meet the state’s future drinking water demands, the 2018 *TN H2O* document states “there exists an important bond between groundwater and surface water in Tennessee. Understanding this relationship is crucial in assessing short- and long-term effects on water quantity, water quality, ecosystem and habitat vitality, waste discharge and assimilation, and availability of clean drinking water. Simply put, what happens in one resource can directly impact the other.” Additionally, “the infrastructure to make that happen is a critical need.”

The 2018 *TN H2O* plan further states “there are clear differences as to level of service for water, by county and even by community. It is difficult to make broad generalizations as to the adequacy of the system because for the most part, water service is provided in so many ways by so many entities.”

Delivering high-quality and reliable water requires significant investment in water treatment and infrastructure by upgrading aging facilities. The Tennessee Department of Environment and Conservation (TDEC) maintains a database for each public water system in the state. TDEC also conducts sanitary surveys of each public water system on a biannual basis in order to identify system deficiencies and issue notices of violations to water systems. TDEC also requires the submission of water loss data on an annual basis by public water systems.

Unaccounted for water, primarily due to leaky pipes in distribution systems, puts a financial drain on a water utility. Utilities must constantly monitor and maintain their system, as well as their accounting procedures, in order to maintain an acceptable level of unaccounted for water. In Tennessee, unaccounted for water losses of 30% or greater are common, far above the 15% threshold of acceptable water loss. Of the 212 Tennessee drinking water systems that filled out

the 2022 Infrastructure Scorecard for infrastructure funding, the average water loss among all systems was 33%, with 43 systems having water loss that exceeded 40%. The average age of most water pipes in the country is over 40 years old, and in some Tennessee cities, more than half of the water pipes are over 40 years old. As such, Tennessee’s aging water main infrastructure needs to experience an increase in replacement or rehabilitation programs.

FUNDING

The state’s Drinking Water State Revolving Fund (DWSRF) has awarded more than \$300 million in low-interest loans since its inception in 1996. To meet the state’s infrastructure needs, during fiscal year 2021 TDEC awarded \$7,171,000 in drinking water loans. During fiscal year 2022, TDEC awarded \$26,192,400 in drinking water loans, with the year over year increase largely due to the infrastructure bill signed in November 2021. In 2021, Tennessee’s Financial Stimulus Accountability Group (FSAG) dedicated over \$1.35 billion of the Tennessee’s Fiscal Recovery Funds from ARP to water, wastewater, and stormwater infrastructure projects. The fiscal year 2022 federal allocation for Tennessee DWSRF is over \$105 million with the breakdown as follows:

DWSRF BIL Supplemental	\$12,172,000
DWSRF Capitalization Grant	\$31,253,000
DWSRF BIL Lead Service Line	\$49,243,000
DWSRF BIL Emerging Contaminants	<u>\$13,123,000</u>
Total DWSRF	\$105,791,000

Source: TDEC presentation May 2022

TDEC is funding water infrastructure projects that align with EPA’s DWSRF eligibility and Water Infrastructure Program Priority Areas, such as addressing significant non-compliance, comprehensive asset management planning, line replacement, modernization of facilities, water reuse, regionalization and consolidation. “ARP funds cannot be used to fund drinking water growth projects, as these projects are ineligible under DWSRF program. Current need must be established for drinking water capacity development projects to be eligible expenses. TDEC is targeting systems that aim to improve the quality of public drinking water supplies for existing customers and provide service to existing communities that have yet to receive safe, reliable drinking water as a part of this offering.” TDEC further suggests that “communities consider using ARP funds to plan for anticipated population growth. Planning may involve developing or improving asset management plans to understand the system’s current assets and capacity or investigating and planning for anticipated needs.”

The Water Infrastructure Finance and Innovation Act (WIFIA) program accelerates investment in our nation’s water infrastructure by providing long-term, low-cost supplemental loans for regionally and nationally significant projects. Since fiscal year 2017, WIFIA has selected 192 projects nationally for WIFIA loan application. In total, selected borrowers have requested nearly \$30 billion. As of the date of this publication, three utilities in Tennessee have been selected to receive WIFIA funding for drinking water related projects. The City of Oak Ridge requested a

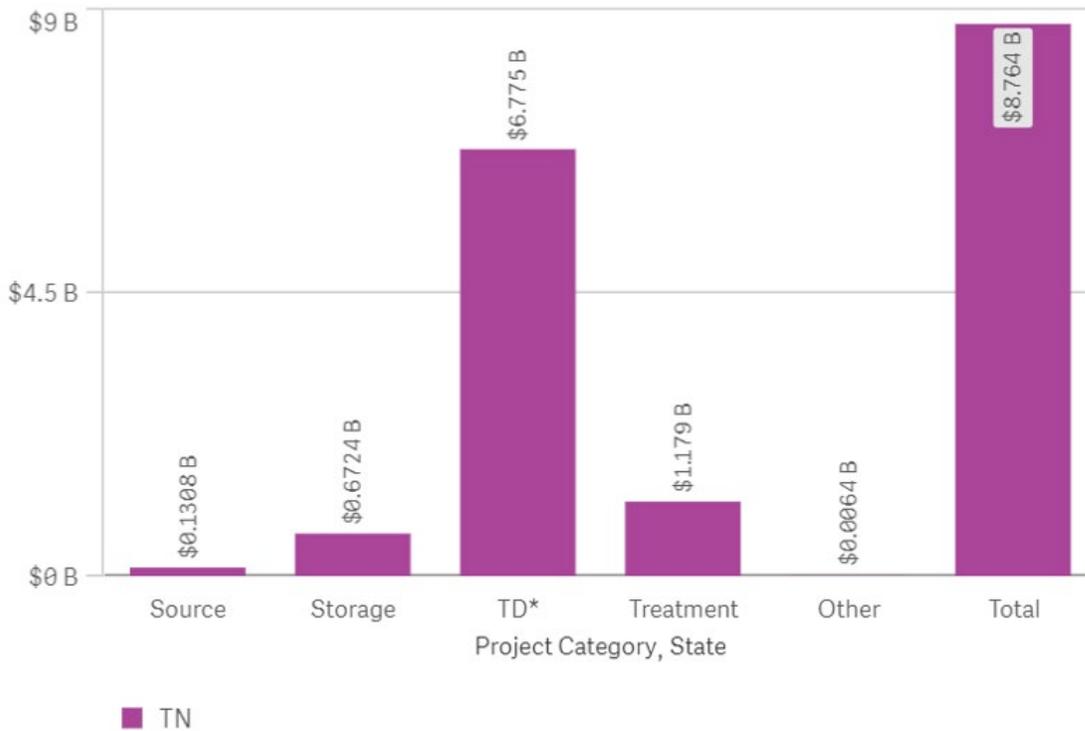
WIFIA loan of \$20.7 million for a \$42.2 million water treatment plant design and construction project. The Oak Ridge project will provide enough capacity to meet the city’s water needs by continuing the production and delivery of safe potable drinking water to its customers. Columbia Power & Water Systems requested a \$106 million WIFIA loan for its long-term water supply program. The purpose of the program is to meet the increasing water demands of the customer base, while providing drought resiliency for the region. Lastly, Metro Water Services requested a WIFIA loan of \$186 million for the City of Nashville for process advancements at Omohundro and K.R. Harrington water treatment plants. The project will also upgrade the Omohundro plant to increase the capacity. The project aims to provide water quality advances beyond the existing water treatment process, including addressing unregulated contaminants.

FUTURE NEED

EPA's 6th Drinking Water Infrastructure Needs Survey and Assessment (2020) shows that \$8.7 billion (in 2015 dollars) is needed to maintain and improve Tennessee’s drinking water infrastructure over the next 20 years, as shown below.

Tennessee

20-year Need Reported by Project Category (in January 2015 dollars)



TD = Transmission and Distribution

The assessment shows that improvements are primarily needed in:

- Distribution and transmission: \$6.8 billion to replace or refurbish aging or deteriorating pipelines

- Treatment: \$1.1 billion to construct, expand or rehabilitate infrastructure to reduce contamination
- Storage: \$0.7 billion to construct, rehabilitate or cover water storage reservoirs
- Source: \$0.1 billion to construct or rehabilitate intake structures, wells and spring collectors

While the initial \$105 million FY22 investment will make a difference in the state, continued investment is necessary to ensure drinking water facilities throughout the state can produce and deliver safe water.

Another water infrastructure funding assessment was made by the Tennessee Advisory Commission on Intergovernmental Relations (TACIR) in the 2022 report, entitled *Building Tennessee's Tomorrow*. The report included an infrastructure water and wastewater needs inventory by County for July 2020 through June 2025. While the report does not reflect water exclusively, the collective water and wastewater estimated cost reflected \$4.9 billion, and over 900 projects.

PUBLIC SAFETY

Tennessee's water quality continues to improve as more stringent discharge standards are implemented. TDEC's Division of Water Resources "is charged with general supervision over construction and operation of public water works systems and is authorized to adopt and enforce rules and regulations governing the location, design, construction, continuous operation and maintenance of these facilities. It also conducts an enforcement program, which requires water suppliers to meet requirements of the Safe Drinking Water Act." The professionals that operate a water treatment plant or distribution system are well trained and certified by the state. By law, the public water system is required to notify its constituents if the public drinking water source fails to meet water quality standards. For the approximate 5 percent of the state's population that uses a private water supply (mainly groundwater wells or springs), the safety of the drinking water is the responsibility of the owner, and the quality is unregulated.

In 2021, federal regulations related to lead in drinking water required that Tennessee water systems begin an inventory by determining ownership of the service lines, and their installation dates. The Lead Service Line Inventory (LSLI) will identify the materials of service lines connected to the public water distribution system with the purpose of identifying areas most in need of replacement. The U.S. Environmental Protection Agency (EPA) and the State of Tennessee require LSLI information to be submitted by October 16, 2024. In 2018, Tennessee Legislation session Public Chapter 977 passed, which requires school districts to implement policies to test for lead in drinking water sources in local schools.

TDEC is also taking steps to address per-and polyfluoroalkyl substances (PFAS) in Tennessee. The department has formed an interdisciplinary working group focused on PFAS contamination. In October 2021, the EPA released the "[PFAS Strategic Roadmap: EPA's Commitments to Action 2021-2024](#)" which sets timelines by which EPA plans to take specific actions to address PFAS and to protect public health. On June 15, 2022, the EPA issued new and updated drinking water health advisories for four PFAS chemicals based on the agency's assessment of the latest peer-reviewed science and health data. EPA released interim updated drinking water lifetime health

advisories for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) that replace those issued by EPA in 2016. TDEC is preparing for a statewide effort to sample all public drinking water system sources for 29 PFAS.

EPA's Enforcement and Compliance History Online website reflects drinking water compliance by Tennessee. Tennessee's community water systems were 99% compliant based on facility inspection and enforcement data. TDEC's Annual Compliance Report for the past 5 years reflects an annual average number of violations near 300 total with the majority related to monitoring requirements.

RESILIENCE & INNOVATION

As water quality and supply issues become more essential in Tennessee as the state's population continues to grow, security and emergency response planning are a critical part of managing a drinking water system. In October 2018, America's Water Infrastructure Act (AWIA) was signed into law and, for drinking water systems serving over 3,300 residents, AWIA Section 2013 requires a Risk and Resilience Assessment and emergency response plans (ERPs). ERPs aim to address and mitigate threats, vulnerability, and the consequence of natural disasters, as well as malevolent acts to drinking water systems. AWIA establishes deadlines by which water systems must certify to EPA completion of the risk assessment and ERP.

In Tennessee, TDEC monitors drought conditions and posts the "Tennessee Water Systems Currently Impacted" by drought on their website. Additionally, TDEC requires each community water system to have an Emergency Operations Plan (EOP). Chapter 1200-5-1-.17 (7) of Tennessee's Safe Drinking Water Rules states "all community water systems shall prepare an emergency operations plan in order to safeguard the water supply and to alert the public of unsafe drinking water in the event of natural or man-made disasters." TDEC also requires that community water systems have a drought management plan that is separate from their EOP.

In Tennessee, a proactive and collaborative management approach to both flood and drought is necessary to keep communities resilient. In accordance with the American Society of Civil Engineers (ASCE) Policy 360 on the impact of climate change, as well as ASCE Policy 500 on resilient infrastructure, strong coordination and collaboration across federal, state, and local government is necessary. This, coupled with investment in research, will enable optimal preparations and responses that can mitigate the impacts to our drinking water. As stated in *TN H2O* "Tennessee must continue to embrace new and creative technologies, such as water reuse. This must be done with a focused pursuit of identifying unintended consequences while also creating incentives for successful implementation of such practices."

RECOMMENDATIONS TO RAISE THE GRADE

- Lower the amount of drinking water violations through implementing water system asset management programs to prioritize investment in critical infrastructure and manage assets from a life-cycle perspective.
- Increase investments that repair and improve Tennessee's public water systems.
- Develop more accurate, quantitative data on public water systems. This includes data on populations served, unaccounted use, water main breaks and replacement, and capital needs.

- Consider options for water reuse to reduce the need to develop and rely on new water supplies.

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Energy: C+

SUMMARY

In 1933, Congress established the Tennessee Valley Authority (TVA) to foster economic development, control flooding, and promote the integration of its natural resources. Almost 90 years later, TVA operates the nation's largest public power system: generating and transmitting power to a population of nearly 10 million people and 700,000 businesses including Tennessee, Alabama, Mississippi, Kentucky, Georgia, North Carolina, and Virginia. TVA has operated with 99.9% reliability over the past twenty years while utilizing ASCE standards. Local power companies (LPC) take electricity from TVA and distribute to residents. Much greater public data from LPCs are necessary for decision-makers to understand Tennessee's energy infrastructure needs.

TVA: GENERATION AND TRANSMISSION

Condition, Capacity, Operations and Maintenance

TVA's generating assets consist of the following: 29 conventional hydroelectric sites, one pumped-storage site hydroelectric site, six coal-fired sites, three nuclear sites, 17 natural gas and/or oil-fired sites, one hundred and one diesel generator sites, and 14 solar energy sites. The total power capacity is 33,727 MW and the portfolio breakdown is: 44% nuclear, 14% coal, 26% natural gas, 11% hydroelectric, 3% wind, and 1% solar.

TVA continues to consider coal phaseout a target that will depend on environmental studies and economic sense. In the past five years, TVA has replaced several coal-fired facilities with natural gas-fired units to maintain a low-cost and efficient generating fleet. Additional coal-fired facilities are planned to be retired in the coming years.

TVA nuclear power generators play a crucial element in a diversified portfolio. The Watts Bar Facility became commercially operational in May 1996 and October 2016 with forty-year operating licenses for each unit. Both units have a combined capacity of 2,332 MW to power over 1.4 million homes.

The Browns Ferry Nuclear plant came online in 1974, 1975 and 1977 covering the three units with the ability to produce maximize power output an additional 3,952 MW. In 2006, the United States Nuclear Regulatory Commission (NRC) renewed the licenses for all three units extending their operation for twenty years past their original 40-year licensing period.

The third plant of the triad is the Sequoyah Nuclear Facility. The two units became operational in 1981 and 1982. They are licensed to operate until 2040 and 2041. The two units at Sequoyah produce more than 2,440 MW of electricity for nearly 1.5 million homes.

In addition to generating power, TVA additionally acquires power from a variety of producers. This is done using power purchase agreements (PPAs). As of September 30, 2020, those currently operating include:

- Non-renewable PPAs with the following types of facilities: 2 natural gas, 1 lignite, and several small diesels.

- Renewable PPAs with the following types of facilities: 8 wind, 3 utility-scale solar, 1 landfill gas, 1 hydroelectric, and approximately 4,000 small-scale facilities contracted under TVA renewable programs.

As a power provider, TVA operates one of the largest transmission systems in North America. It extends approximately 16,200 miles and provides a critical link from the generating plants through a network of 153 LPCs to 10 million people in the Tennessee Valley. TVA continually invests in new transmission lines and facilities to ensure reliable delivery of power where and when it is needed, regardless of fluctuations in demand or weather.

TVA's transmission system is a critical link in moving electricity throughout the eastern United States. TVA has operated with a 99.999 percent reliability over the past twenty years. The construction of the nuclear power plant assets supported the need to build new high voltage power lines to distribute electrical power to the LPCs, industrial and commercial load, and the federal government. The remaining power transmission and distribution system were constructed as fossil fuel plants and hydroelectric facilities were built. The transmission system interconnects with systems of surrounding utilities and consists primarily of the following assets as of September 30, 2019.

- Approximately 2,500 circuit miles of 500 kilovolt (kV) transmission lines.
- 11,700 circuit miles of 161 kV transmission lines.
- 2,000 circuit miles of other voltage transmission lines.
- 3,500 miles of fiber optic communication lines.
- 520 transmission substations, power switchyards, and switching stations.
- 1,314 customer connection points (customer, generation, and interconnection).

In 2019, the TVA Board adopted its first Integrated Resource Plan (IRP) providing direction on how TVA can best meet future demand for power. It shapes how TVA will provide low-cost, reliable, and clean electricity; support environmental stewardship; and foster economic development over the next 20 years. TVA's adoption of its IRP is a long-term strategic plan that provides a vision on future expansion of capital improvements to meet TVA's goals.

In May 2017, the TVA Board authorized up to \$300 million to be spent over the following 10 years subject to annual budget availability and necessary environmental reviews, to build an enhanced fiber network that will better connect TVA's operational assets. Additionally, TVA plans to spend over \$500 million dollars between fiscal year 2019 and 2021 for transmission improvements.

TVA's rate structure is one of the lowest in the region. However, it has received criticism by the Southern Alliance for Clean Energy as recently as in January 2018 for its underlying methodology used to set rates for each customer base. The Southern Alliance for Clean Energy concluded that residential customers are shouldering rising rates while large industrial customer rates decline. They recommend greater transparency by TVA in their ratemaking methodologies to address these issues.

Funding and Future Needs

The 2019 IRP indicates that the following near-term actions would provide benefits across multiple futures:

- Add solar based on economics and to meet customer demand.
- Enhance system flexibility to integrate renewables and distributed resources.
- Evaluate demonstration battery storage projects to gain operational experience.
- Pursue option for license renewal for TVA's nuclear fleet.
- Evaluate engineering end of life date for aging fossil units to inform long term planning.
- Conduct market potential study for energy efficiency and demand response.
- Collaborate with states and local stakeholders to address low-income energy efficiency across the Valley.
- Collaboratively deploy initiatives to stimulate the local electric vehicle market.
- Support and development of Distribution Resource Planning for integration into TVA's planning process.

In addition to adoption of the IRP, TVA makes annual investments in science and technology innovation. The Agency focuses on emerging technological advances, grid modernization, electrification, grid edge technologies and Distributed Energy Resources.

The current number of households inside the TVA region is estimated at 4,216,300 and rising to 4,375,770 by 2026. An additional 159,470 homes results in an estimated additional demand on power from TVA of 350 MW. The estimated generation capacity of TVA is 34,000 MW.

Public Safety

TVA selling point to its publicly owned LPCs continues to be its high degree of reliability in its power generating and transmission facilities. TVA has strict safety expectations in place for everyone who works on their sites. These safety expectations are addressed in site specific safety plans that must be approved thirty days prior to the beginning of work.

Fifteen years ago, TVA suffered its most publicly advertised environmental disaster when toxic coal ash at the Kingston coal fired power plant breached its containment dikes and flooded downstream properties. This incident impacted both people's lives and property damage. In May 2020, the National Council for Occupational Safety and Health cited TVA as being in the top twelve of the nation's "Dirty Dozen" workplace safety scofflaws due to the coal ash spill.

In August 2019, TVA encountered labor relations issues with the U.S. Department of Labor regarding "whistle blowers" covering nuclear safety concerns.

The FY 2021 Budget and Management agenda lists a number of environmental violations of significance and number of reportable environmental events over the last six years. TVA continues to correct the violations and change safety protocol to attempt to eliminate the problem areas.

Resilience

In past years, TVA has undergone engineering resilience studies of its power generating plants to protect assets from domestic terrorism and natural disaster. This management plan is incorporated into the IRP. As new facilities are constructed or reconstructed, the suggestions and recommendations are instituted.

Innovation

In addition to adoption of the IRP, TVA makes annual investments in science and technology innovation. The Agency focuses on emerging technological advances, grid modernization, electrification, grid edge technologies and Distributed Energy Resources. Its goal is to reduce cost, improve/sustain reliability, lower emissions to the environment and position TVA for a sustainable future.

As previously mentioned, the TVA Board previously authorized for up to \$300 million to be spent over the next 10 years to build an enhanced fiber network to better connect TVA's operational assets. Fiber is a vital part of TVA's communication infrastructure. The new fiber optic lines will improve the reliability and resiliency of the generation and transmission system, improve TVA's communications with LPCs and other entities, and enable the system to better accommodate distributed energy resources as they enter the market.

TVA's core research activities support modernization and optimization of TVA's generation and transmission assets, air and water quality, and distributed/clean energy integration. The current research strategy focuses on components of distributed energy resources (the power system), including sustainability, generating fleet optimization, grid modernization, cyber security, data analytics, and grid edge engagement. TVA's distributed/clean energy research efforts explore the scope and impact of integrating solar, photovoltaics, electric vehicles, and battery storage on operations business economics and strategies.

DISTRIBUTION: CITY OF MEMPHIS-SHELBY COUNTY

The following information pertaining to MLGW Electric Division was collected from the following sources:

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Condition, Capacity, Operations and Maintenance

Memphis Light, Gas and Water (MLGW) is the largest three-service municipal utility in the U.S. with more than 430,000 customers. It is owned by the City of Memphis, Tennessee.

MLGW is TVA's largest customer, representing 11% of TVA's total load. MLGW is TVA's largest customer, representing 11% of TVA's total load. MLGW purchased power and gas for resale in 2021 for \$985,215 and in 2020 for \$939,781. MLGW has a residential electricity rate of 7.9 cents per kilowatt hour (7.8 cents per kilowatt hour after the first 500 kilowatt is used).

The state's average rate is 11.12 cents per kilowatt hour.

TOTAL KWH BY SERVICE AREA

Service Area	2021	2020	2019
City of Memphis	9,800,375	9,672,364	10,208,674
Shelby County and Other Suburban Communities	3,207,752	3,101,814	3,278,269

The following tables provide statistical data on the nature and characteristic of the services load of MLGW.

CUSTOMERS PER CALENDAR YEAR

Customer	2021	2020	2019
Residential	378,516	375,625	371,771
Commercial	44,033	43,695	43,392
Industrial	100	105	112

KWH/CUSTOMER/CALENDAR YEAR

Customer	2021	2020	2019
Residential	13,889	13,601	14,415
Commercial - General Service	132,182	128,517	140,042
Industrial	17,365,650	16,953,914	15,945,428

2021 CAPITAL ASSETS

Structures and improvements	\$72,593,000
Transmission and distribution plant equipment	\$1,624,494,000
General plant equipment	\$191,398,000

MLGW reported a yearly loss of approximately 3.58% of the electricity that they transmit. The state of Tennessee has an energy loss average of 2.57% and the nationwide average is 2.76%, giving MLGW a rank of 20th best out of 84 providers who report energy loss in Tennessee.

MLGW operates and maintains 161 kV transmission lines and distribution lines to provide power to its residential and commercial service area. They own and operate approximately 4650 miles of transmission and distribution power lines

Funding and Future Needs

As part of the MLGW’s five-year Capital Improvement Plan proposed with the 2020 Budget, approval was granted for a \$1 billion improvement plan across its three divisions. The increases will be used primarily to fund infrastructure improvements.

During 2021, the MLGW Electric Division expended \$71.8 million on construction activities and capital purchases.

2021 Major Electric Division construction expenditures included:

- substation and transmission projects (\$31.4 million),
- extensions to serve new customers (\$13.7 million),
- additional planned and emergency distribution projects and general plant purchases (\$9.6 million),
- distribution automation (\$7.7 million),
- distribution pole replacement (\$3.9 million),
- security automation upgrades (\$3.1 million), and
- storm restoration (\$2.4 million).

A reliable, cost-effective power supply is critical to the economic viability and the overall quality of life in Memphis and Shelby County. As the utility company that serves this community, MLGW has a goal to ensure they are providing the most reliable and affordable power available.

The Division is currently discussing plans to consider expanding underground installation of electric operations to improve reliability under severe weather conditions. During February 2021, Memphis suffered a historic winter storm causing approximately 42,000 customers to lose power.

In 2019, MLGW completed a comprehensive Integrated Resource Plan (IRP) for the purpose of evaluating reliable and cost-effective alternatives to the existing full requirements contract with the Tennessee Valley Authority (TVA). As a result of this IRP process, which included extensive stakeholder input, a set of three resource portfolios were recommended for further evaluation. The three resource portfolios contain various levels of natural gas-fired generation as well as renewable energy resources to be installed in Memphis/Shelby County. Since that report was completed, TVA has completed a natural gas-fired generation plant to supply power to the Memphis-Shelby County metro area.

As per the 2021 IRP, approximately 145 miles of local 161 kV MLGW owned transmission lines were identified for upgrades to avoid any potential reliability violations under the proposed transmission expansion plan. The estimated total upgrade costs are approximately \$164 million. To meet future needs and growth, MLGW embarked on an extensive evaluation of power supply options covering electric transmission, thermal generation, and renewable power supplies. Based on the IRP completed for this analysis, MLGW's Power Supply Evaluation Team, on September 1, 2022, determined that a continuing relationship with TVA under a Long-Term Partnership Proposal demonstrated the greatest value and least risk for MLGW customers compared to all other alternatives. MLGW's continued working relationship with the TVA ensures the pursuit of a long-term contract for supplying power to MLGW under MLGW's desire for renewable and other alternative resources.

The Division recently celebrated a milestone for the completion of over 500 homes weatherized in March 2021 through Share the Pennies. MLGW was also awarded a \$750,000 grant from the

Tennessee Department of Environment and Conservation (TDEC) to provide weatherization and energy efficiency repairs for qualified, limited-income homeowners in Shelby County.

Public Safety

Recently MLGW was recognized for public and employee safety in this area. In 2021, MLGW received the RP3 Diamond Award (highest recognition) from the American Public Power Association. A RP3 designation is a sign of a utility's dedication to operating an efficient, safe, and reliable distribution system. MLGW has been recognized through the RP3 program five times since 2010.

Resilience and Innovation

Over the past few years, MLGW has instituted an outage map that provides general information about outage level across Shelby County.

This year, MLGW embarked on a project to reduce power outages within its power distribution system. The project plan calls for 'self-healing smart grid' distribution system to help reduce power outage times. The project is anticipated to cost \$132 million and take five years to complete.

Business and residential customers can receive real time outage notifications using MLGW's outage text alert notification system. This new feature is another way to communicate with customers in addition to the other communications platforms. Another recent innovation is that MLGW customers can complete Residential Service Agreements electronically.

MLGW has migrated to the Microsoft Office 365 platform and upgraded the existing Oracle Enterprise Business Solution, which provides current employees with better tools to complete projects and tasks.

As 5G networking becomes a requirement to lifestyle and corporate business, the Electric Division has increased staffing to support the demand required with pole attachment work.

DISTRIBUTION: NASHVILLE ELECTRIC SERVICE

The following information pertaining to NES was collected from the following sources

1. 2021 Annual Report
2. 2021 Fiscal Facts
3. NES Website
4. 2019 Fitch Report on Financial Capacity of NES
5. Various websites such as news reports, public notifications, and Wikipedia.

Condition, Capacity, Operations and Maintenance

Nashville Electric Service (NES) was founded on August 16, 1939 and is one of the 12 largest public electric utilities in the United States, distributing electric power to more than 419,000 customers in middle Tennessee. The NES service area covers 700 square miles, which consists of all of Nashville Davidson County and portions of the six surrounding counties. The NES infrastructure includes 97,234 distribution transformers, 208 distribution substations, 5,928 circuit miles of transmission and distribution powerlines, 211,087 poles, 64,125 streetlights in

service, and 29 interchanges each with a capacity of 161 kV from TVA, which provides significant redundancy.

NES purchases electric power from the TVA. For the past two years, the amount of power purchased was \$850,409 in calendar year 2021 and \$887,729 in calendar year 2020.

NES services over 5,900 miles of distribution and transmission lines daily. No data exist to show the breakdown of transmission lines and distribution lines.

NES reported a yearly loss of about 3.37% of the electricity that they transmit. The state of Tennessee has an energy loss average of 2.57% and the nationwide average is 2.76%, giving NES a rank of 16th best out of 84 providers who report energy loss in Tennessee.

NES has an average residential electricity rate of 13 cents per kilowatt hour. This is over 15% higher than the state's average rate of 11.12 cents, resulting in the company ranking 84th best for average electricity price out of 90 suppliers in the state.

NO. OF CUSTOMERS FOR CALENDAR YEAR

Customer	2021
Residential	382,307
Commercial	45,022
Industrial	60

KWH/CUSTOMER/CALENDAR YEAR

Customer	2021
Residential	19,056
Small Commercial	791
Large Commercial	5743

2021 CAPITAL ASSETS

<i>Structures and improvements</i>	<i>\$76,398,000</i>
<i>Transmission and distribution and plant equipment</i>	<i>\$1,696,392,000</i>
<i>General plant equipment</i>	<i>\$139,121,000</i>

PEAK DEMAND AND CONSUMPTION

WINTER	Consumption in kW
Peak High Day for Fiscal Year 2021 (2/16/2021)	2,350,695

All Time High Day (1/6/2014)	2,638,688
All Time High Month (January 2014)	1,279,715,809
SUMMER	
Peak High Day for Fiscal Year 2021 (07/20/2020)	2,429,835
All Time High Day (08/09/2007)	2,712,356
All Time High Month August (2007)	1,499,527,106

During Nashville’s growth in the 1980’s and 90’s, NES increased the load capacity of its system. In recent years, NES has weathered natural disasters, including a 1,000-year flood in 2010 that forced the utility to rebuild significant portions of the electrical system to restore power.

NES reports peak demand and consumption. However, information could not be found indicating if and where peaking demands were impacting local areas of the electrical grid. These areas should be identified and recorded to plan for improvements.

Funding and Future Needs

The NES Board continues to invest in the utility plant. Major projects during fiscal year 2021 included \$39.8 million in system construction related to planned capacity; \$20.8 million in system construction related to asset management; \$18.2 million in new business installation; and \$16.3 million in equipment and facilities. However, expenditures are not related to a capital improvement plan, therefore clarity and openness remains opaque.

NES does not have a publicly available Integrated Resource Plan (IRP). Integrated Resource Planning is considered Best Practices Guide. An IRP determines whether a utility has sufficient resources to satisfy projected retail loads over a ten-year period. The second purpose establishes objectives such as affordability, of electricity, reduced greenhouse gas emissions, reduced water consumption, diversified electricity generation sources for localization and regional development.

Public Safety

NES is among only four percent of all public utilities in the country to receive the Reliable Public Power Providers Diamond Award, the industry’s highest honor for providing safe and reliable electricity for customers.

Resilience and Innovation

NES recognizes the importance of the recently passed Inflation Reduction Act to support energy saving and renewable power options for the Nashville metro area. However, currently, the program remains in a state of development. NES plans to help and support those in need to weatherize and reduce lost energy associated with cooling and heating. In addition to providing

power saving improvements to its customers, NES continues to push TVA, its supplier of electric power to move away from fossil fuels and develop renewables.

In 2018, Nashville in conjunction with TVA, constructed its first solar park contributing carbon free energy back to its electrical grid. As of this year, the park has generated approximately 10,948 kWh. Nashville was the first local government to sign a Green Invest contract in the TVA territory, committing to 100 MW of solar in partnership with NES, TVA, and Vanderbilt University. Metro's commitment is part of a 200 MW project in Middle Tennessee that is expected to be online in early 2024. The clean energy from this project will power Metro's buildings across the city and will help meet interim goals for renewable power established in ordinance

In addition to consumer benefits, there are benefits for business owners as well. Businesses will be able to claim credits to replace traditional cars with electric vehicles, saving as much as 30% on the cost of each vehicle purchased. Additionally, building credits will have a longer expiration date, and will be available to publicly owned nonprofits and utilities, like NES.

NES informs the public of outages through its online outage map. However, events are not recorded, or data compiled for record keeping. Outages should be included in the annual report prepared for the Board and public.

RECOMMENDATIONS

1. Publicly owned power company should provide more information to the public pertaining to system improvement covering transmission and distribution lines. A capital improvement plan is essential for reliable and consistent service to the public and must be provided to its customers for clarity and transparency.
2. Publicly owned power companies should adhere to construction standards adopted by nationally recognized societies such as American Society of Civil Engineers and Institute of Electrical and Electronic Engineers. These standards lay the foundation and benchmark for safe and reliable delivery of electric power to customers.
3. Integrated Resource Plans are vital to publicly owned power companies. The State of Tennessee does not require publicly owned power companies to undertake this analysis of their system. Components of an Integrated Resource Plan vary from state to state and considered best management practices for operating an electric utility. Steps taken in the creation of an IRP may include: any or all of the follow such as forecasting future loads, identifying potential resource options to meet those future loads, determining the optimal mix of resources based on the goal of minimizing future electric system costs, receiving and responding to public participation (where applicable), and creating and implementing the resource plan, assessment and improvements to the electric grid consisting of distribution and transmission powerlines, switching stations, transfer stations. Summarizing this analysis provides for reliable future electric service to its members in future years. A critical element in this process includes TVA which is the main supplier of electric power for the state.

4. Publicly owned power companies should engage in the research and promotion of distributed power systems that provide a safe and environmentally compatible power source within its power grid. Examples of carbon free energy production facilities such as the solar park in Nashville may be enhancement projects partnered with TVA.
5. Annual fiscal reports should track operating inputs and outputs for benchmarking and to assess the operation, maintenance, and safety of the company rather than relying solely on fiscal and monetary data to drive improvements.
6. Publicly owned power companies should establish and enhance client-member relationship that build upon efficiency, dependability, openness, and clarity. Billing software and associated reports must provide information for the user of the facility to plan accordingly.
7. Publicly owned power companies should leverage the use of geographical information system to improve the reliability, durability, and efficiency of the electrical grid to contact consumers during times of outages and emergencies.
8. Publicly owned power companies should leverage with private individuals and companies to develop electric filling stations for the rising number of electric vehicles (EV's). Situational locations for such electric filling stations will most certainly impact electric demands that may require special power feeds.
9. Publicly owned power companies should leverage their knowledge and experience of working with financial institutions to provide financial loans and/or grants to promote and enhance energy savings for their consumers.
10. Publicly owned power companies should review, assess, and upgrade their facilities to reduce lost power that they transmit. Targets should be set to recapture and reduce transmitted lost power.

SOURCES

References, excerpts, and notes were pulled from the following reports and documents to compile this abbreviated report:

- TVA FY 2019 Budget Proposal and Management Proposal
- 2019 Integrated Resource Plan
- and numerous magazine and newspaper articles

Inland Waterways: C

Summary

Tennessee's locks and dams are located across 950 miles of inland waterways made up of the Cumberland, Mississippi, and Tennessee Rivers. Long-deferred capacity and condition improvements are finally taking place along the system. However, most efficiency enhancements have yet to be realized. At the Chickamauga Lock, 5-inches concrete expansion caused by chemical reaction is threatening the structure. A new lock, measuring 110 feet by 600 feet, is under construction, but the earliest completion date is 2024. At the Kentucky locks on the Tennessee River, tows frequently exceed 600 feet, requiring double locking that drives the average delays up to nine hours – the highest in the inland waterways system. A new project is underway to add a 1,200-foot navigation lock on the landward side of the existing locks. This will greatly increase the capacity of this section of waterways by allowing longer tows to pass through without double locking.

Introduction

The state of Tennessee is located at the heart of the nation's inland waterways system. Over 950 miles of waterways on the state's three major navigable arteries, the Cumberland, Mississippi, and Tennessee Rivers and their tributaries, connect the state's five public river ports and over 170 private river terminals to river ports in 21 states and ocean ports along the Gulf Intracoastal Waterway.

Inland waterways are crucial to the Tennessee and national economies. A study conducted for the National Waterways Foundation by researchers from the University of Kentucky (UK) and the University of Tennessee (UT) concluded that, throughout the nation, the inland waterways system supports nearly 550,000 domestic jobs, \$29 billion in corresponding income, and \$125 billion in aggregate economic output annually.

Capacity

The Mississippi River borders the western boundary of the state and contains the International Port of Memphis, the fifth largest inland port in the U.S. and the second largest shallow draft port on the river. Of the 68 water-fronted facilities, 37 are terminal facilities moving products such as petroleum, tar, asphalt, cement, steel, coal, salt, fertilizers, aggregates, and grains. The port created 9,128 direct and 13,337 indirect jobs, according to a December 2018 Economic Impact Study from the Memphis and Shelby County Port Commission.

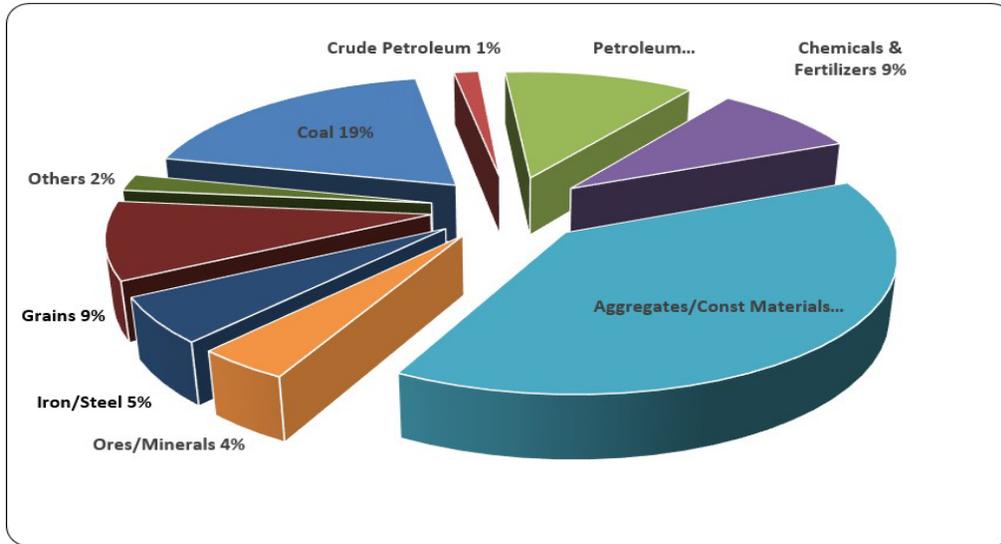


Figure 1. Goods Moved on Rivers in Tennessee (Tennessee, Clinch, Cumberland, and Mississippi Rivers)

The Tennessee River has 694 navigable miles and is formed at the confluence of the Holston and French Broad Rivers on the east side of Knoxville. The following locks are located along its length:

- | | |
|--|--------------------------------------|
| Fort Loudoun Lock – Mile 602.3 | Wheeler Lock – Mile 274.9 (Alabama) |
| Watts Bar Lock – Mile 529.9 | Wilson Lock – Mile 259.4 (Alabama) |
| Chickamauga Lock – Mile 471.0 | Pickwick Lock – Mile 206.7 |
| Nickajack Lock – Mile 424.7 | Kentucky Lock – Mile 22.4 (Kentucky) |
| Guntersville Lock – Mile 349.0 (Alabama) | |



Figure 2 - Map of Tennessee River Dams and Reservoirs

The Clinch River is a tributary of the Tennessee River and navigation on the river is limited to 61 miles from its confluence with the Tennessee River to Clinton, TN. It primarily provides development to the area between Oak Ridge and Knoxville. One lock is located at:

Milton Hill Lock – Mile 23.1

The Cumberland River has some 650 miles of navigable waterways from east to west, from Virginia through the northern section of Tennessee to its confluence with the Ohio River in Kentucky. Locks are located at:

Cordell Hull Lock– Mile 313.5

Cheatham Lock – Mile 148.7

Old Hickory Lock – Mile 529.9

Barkley Lock – Mile 30.6 (Kentucky)

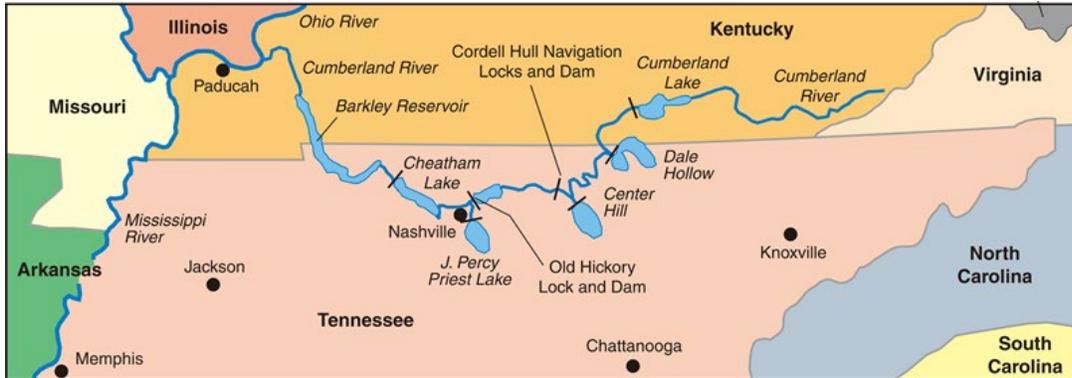


Figure 3 - Map of Cumberland River Dams and Reservoirs

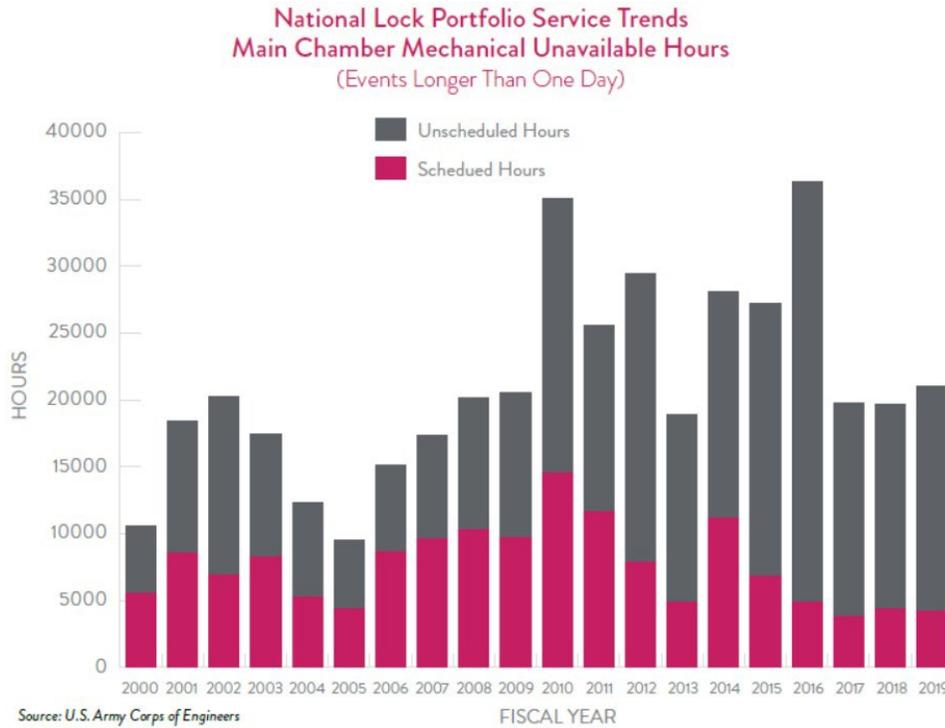
In most of the country, the U.S. Army Corps of Engineers (USACE) has responsibility for the operation and maintenance of commercial navigation projects, while the U.S. Coast Guard (USCG) ensures safe transportation on America’s waterways and protection of the marine environment. USACE maintains and operates the nine navigation locks on the Tennessee River (Figure 2), four navigation locks on the Cumberland River (Figure 3), and a navigation lock on the Clinch River.

USACE also maintains a commercial navigation channel along the segment of the Mississippi River that borders Tennessee. Since there are no locks or dams on the Mississippi River below St. Louis, USACE’s responsibility on this portion of the river is primarily river maintenance for navigability.

On the Tennessee River, however, USACE also works in partnership with the Tennessee Valley Authority (TVA) and the USCG. The locks and dams are owned by the United States and operated by TVA and USACE. In accordance with the Tennessee Valley Authority Act, TVA is entrusted with the possession, operation, and control of the dams and all related buildings, machinery, and lands, with the exception of the navigation locks that are operated by USACE. The USCG installs and maintains navigational aids such as channel markers, day beacons, and navigation marker lights along the commercial channel, which it also does throughout the U.S., while TVA installs and maintains navigational aids on the recreational channels across the Tennessee Valley. These may include secondary stream buoys, mile markers, and other control buoys.

CONDITION AND OPERATION, & MAINTENANCE

Movement through Tennessee’s locks is often delayed due to unscheduled repairs. Repairs to the aging infrastructure are often needed and can take multiple months to completely resolve. Funding for preventive maintenance, reconstruction, and new projects has improved, but the backlog of projects is still growing. Delays may also occur due to low water, which results in light-loading barges and increased shipment costs. Below presents the hours of delays experienced nationally.



While the delay times are generally low, they highlight the infrastructure’s inability to effectively meet current demands. The U.S. Department of Agriculture estimates that delays cost up to \$739 per hour of delay and nearly \$44 million annually.

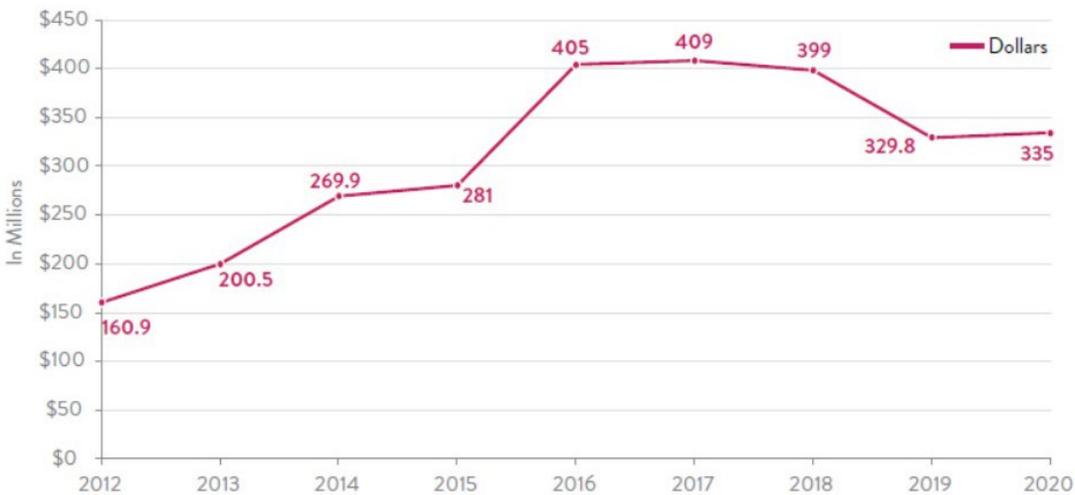
In the event of closures, shippers are often forced to make short-term, emergency arrangements with other product sources and transportation providers in order to keep their generating stations and manufacturing plants operating. Transportation impacts associated with such closures cause material shortages, increase shipping costs, and idle time for tows and their crews. These associated impacts are estimated to cost the economy millions of dollars. Unexpected closures affect both recreational and business (particularly those operating in the water-dependent and barge shipping industries) users of the lock.

At Chickamauga, concrete expansion threatens the continued structural integrity of the lock walls and could result in catastrophic failure. Congress authorized a new lock measuring 110 feet by 600 feet. Construction began in 2004, and the project was initially projected to be completed by 2014. The date of completion was pushed back to 2025, so only the smaller lock is serviceable today. However, Congress recently allocated \$191 million in funding for the next phase of work on the lock.

At the Kentucky locks on the Tennessee River, the length of tows frequently exceeds 600 feet, requiring double lockage that drives average delays up to nine hours, one of the highest in the inland waterways system and costing over \$100,000 per day. A new project is underway to add a 1,200-foot navigation lock on the landward side of the existing locks. This will greatly increase the capacity of this section of waterways by allowing longer tows to pass through without double locking.

FUNDING AND FUTURE NEED

Tennessee’s inland waterways are funded partly through the federal Inland Waterways Trust Fund (IWTF), levied as a diesel tax on commercial towboat operators, and partly through general federal tax revenues, each intended to pay for roughly half of any major rehabilitation of existing facilities or new construction of locks and dams. Once projects are completed, general taxes account for 100 percent of the revenue needed for daily operations and maintenance. The IW diesel tax was increased in 2014. This has allowed more projects to be completed with some funding directed towards system improvement that will impact Tennessee over the next few years.



Source: USACE Inland Waterways Annual Reports, Nos. 24-32⁷

Figure 5 - Construction Funding from the Inland Waterways Trust Fund

If the condition of Tennessee’s locks is not improved, freight will have to be transported by highway and rail systems. This will raise transportation costs and place additional stress on pavement and bridge infrastructure and the highway system. The temporary stoppage of river traffic in 2021 due to the closure of the Interstate 40 Hernando DeSoto Bridge across the Mississippi River showed the importance and highlighted the volume of river traffic passing through our inland waterways on a daily basis.

USACE recently unveiled a plan to spend nearly \$2.2 billion of allocated funding from the Infrastructure Investment and Jobs Act on locks and dams. In early 2022 Congress announced allocating \$465 million for the improvements planned at the newly extended Kentucky lock. This in addition to the \$191 million allocated to the Chickamauga Lock project.

PUBLIC SAFETY AND RESILIENCE

Flooding and concrete expansion inhibit the effective use of the Cheatham Lock and the Chickamauga Lock and Dam, respectively. At present, Cheatham Lock is the only lock within the Nashville district that is designed to allow flooding over the lock walls during high water events. Even so, this lock was heavily damaged by floods in May 2010 and was closed until mid-June of that year.

The problems of spalling concrete at Chickamauga Lock was discussed earlier and work is being done to eliminate this.

INNOVATION

With the availability of information on multiple, often real-time, websites, shippers can plan shipments to avoid delays and possibly reduce costs. With improvements & repairs planned at several locations, the implementation of new designs, controls and monitoring could contribute to delay reduction as well.

RECOMMENDATIONS

- Increase USACE budget to maintain and operate locks and dams.
- Complete the needed Chickamauga replacement locks.
- Complete the additional extended lock at Kentucky lock.
- Repair Melton Hill Lock, Nickajack Lock, Pickwick Lock, and Watts Barr Lock.

Sources

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Public Parks: C+

Executive Summary

The overall condition of Tennessee State Parks facilities infrastructure is improving and safe. Parks funding has improved significantly – a surge of \$28 million for maintenance from the FY2021 budget compared to an average annual spend of \$5 million for those projects. Tennessee State Parks have been actively reducing the deferred maintenance backlog through state appropriations with about 35% of deferred maintenance needs being met over the last 3 budget cycles, and an estimated elimination of the deferred maintenance needs in three to four years. A permanent, dedicated funding source should be created to expand and improve park facilities without again collecting a list of necessary but unfunded projects.

Background

The Tennessee State Park system contains 56 State Parks with 197,306 acres owned by the state and 214,039 acres managed by the park system. Tennessee also has 84 natural areas with 100,627 acres owned and 26,324 acres managed by the state. Most of the Natural areas are contained within the boundaries of the State Parks, along with various historical and archeological sites.

The Tennessee State Parks are run by the Tennessee Department of Environment and Conservation (TDEC) and contain approximately \$704 million in building assets and furnishings. These parks receive approximately \$5 Million for annual maintenance with larger amounts granted periodically for deferred maintenance needs. For the fiscal year ending in 2022, \$28 million was budgeted above the normal annual maintenance funding to address some of the backlog.

Private, municipal, and national parks were not included in this evaluation.

Capacity & Condition

There are six state parks with lodges, 33 with conference centers or meeting locations, 21 with cabins, and 2,357 RV sites along with campsites with multiple recreational amenities ranging from rustic natural and historic sites to restaurants, marinas, and golf courses, and over 1,100 miles of trails. Based on business management plans provided by each Tennessee state park, the parks assessment of park inventory and facilities are well-maintained with most reporting good to fair conditions. There are several instances of park facilities such as campgrounds, bathhouses, maintenance buildings, bridges, theaters, visitor centers, and park offices being closed and rated as poor due to lack of funding for maintenance and inadequate ADA access. Some of the buildings and the infrastructure of the park system are over seventy years of age dating to construction by the CCC. Some older buildings are being replaced through capital expenditures by the state.

Since the COVID-19 pandemic began in 2020, outdoor activities such as camping became increasingly popular both here in Tennessee and around the country. According to Tennessee Department of Environment and Conservation (TDEC), Tennessee state parks saw 38.5 million visitors in 2021, an increase of nearly 4 million from the previous year. While the state parks saw that boost, the start of the pandemic did take a toll on the number of visitors to Tennessee in

general. A report by the US Travel Association saw a 32% drop in visitors to Tennessee, though that is better than the national average at a 42% decline. During the midst of the COVID-19 pandemic, the economic impact of Tennessee State Parks in FY2020 was \$1.84 billion with 34.7 million park visits with 14,514 total jobs, \$110.3 million in state taxes (double what the state general fund contributes to state parks), and \$22.1 million in local county taxes supported by parks activity. In FY2021, the parks generated \$121.8 million in state sales taxes and \$24.4 million in local sales taxes.

The Tennessee Department of Health defines access to parks and greenways as the percentage of the population with adequate access to outdoor locations for physical activity. Individuals are determined to have adequate access to parks and greenways if they: reside in a census block within a half mile of a park, reside in an urban census block within one mile of a recreational facility, or reside in a rural census block within three miles of a recreational facility. Most Tennesseans live within an hour drive of at least one of our state's 56 state parks. In 2016, 71% of Tennesseans were considered to have adequate access to parks or greenways. The data for this measure comes from the Behavioral Risk Factor Surveillance System. In 2020, Tennessee State Parks last year was named among the top four parks systems in the nation by the American Academy for Park and Recreation Administration, in partnership with the National Recreation and Park Association.

Funding

State parks receive financial support from the state legislature appropriations process and user fees. In the 2021-2022 budget year, Tennessee State Parks generated \$48.53 million in revenue from 38,479,604 visitors, compared to state appropriations of \$43.56 million. State support for parks is money well spent. In 2021, Tennessee State Parks had an economic impact of \$2.1 billion, supporting jobs and industries across the state. There are about 1,400 employees of the state park system. The figures for FY2021 show a steady climb in recent years in economic impact and number of visits. Cumulatively in fiscal years 2019-2021, Tennessee State Parks had an economic impact of \$4.3 billion, with 109.7 million visits. The figures reflect parks activity through lodging, shopping and recreation spending. Tennessee State Parks is one of only seven state parks systems in the country that do not charge admission fees.

Federal funding comes to the state from various sources, primarily in the form of grants that require matching funds or the purchase of land for parks, trails, natural areas, greenways, and recreation facilities, maintenance and restoration/rehabilitation, construction and to support park staffing and organization. Funding for these grants come from the Land & Water Conservation Fund (LWCF), Recreational Trails Program (RTP), and the Tennessee Recreation Initiative Program (TRIP). The total impact for FY21 included \$144.6 million in capital improvement projects, \$21.1 million in deferred maintenance projects, \$10.6 million in minor maintenance projects and \$35.2 million in grants projects. For the 2022-2023 fiscal year, federal contributions are anticipated to be \$131,000 for parks and \$90,000 for natural areas. Annual maintenance and capital budget requests are prepared each year by Parks Operations. The most recent capital funding request was \$224 million. The current maintenance deficit of the State Parks has been reduced through increased maintenance allocation from the state budget.

As of August 2022, TDEC announced that more than a dozen cities have received funds to provide improvements to local parks and recreation offerings across the state ranging from the creation of new parks to the improvement of sports fields and building of trails. The state is awarded \$448,000 for the Recreation Trails Program (RTP) as well as \$6.37 million in grants through the Local Parks and Recreation Fund (LPRF) program and the Land and Water Conservation Fund (LWCF) program.

Future Need

From 2015 to 2019, Management Plans for 54 parks were developed to assist local park professionals to better provide services to Tennessee State Parks visitors. The continued yearly goal of Tennessee State Parks is efficient maintenance with carefully selected capital improvement projects. The Natural Areas Program has expanded to preserve Tennessee's natural sites. Tennessee State Parks continue to partner with agencies, communities, and private groups to provide awareness and experience to citizens of the natural and cultural resources provided by the organization.

There is need for accurate information about the value of funding for parks, recreation, and conservation. Parks have been underfunded in Tennessee for many years, yet the state's population continues to grow, and with it demand for more parks and recreation. Tennessee's State Parks produce \$37 in economic impacts for every dollar the state invests in running them, yet at current funding levels, they will be challenged to maintain their high standards of excellence in the future.

As of October 2021, state parks had a deferred maintenance budget of \$10 million. With a priority list of projects developed by Tennessee State Parks, \$6.79 million has been addressed to date. By December 31, 2023, Tennessee State Parks is working to eliminate its highest-priority deferred maintenance items in Tennessee State Parks (\$36 million of the \$82 million identified in 2019) and continue to address emerging high-priority maintenance needs. The parks have a maintenance budget of about \$5 Million each year to address maintenance. For the 2022-2023 fiscal year, an additional \$28 Million was requested in the governor's budget to address deferred maintenance items.

Operations and Maintenance

The State Parks Operation Division in TDEC oversees the operation of 56 state park units, including 6 Resort Inns, 8 Restaurants, 9 Golf Courses, 4 Marinas, 20 Cabin arrays, and 35 Campgrounds. The state increased funding for parks in recent years but support still is needed to eliminate the deferred maintenance backlog. By December 31, 2023, Tennessee State Parks Operations Division will increase its annual net gain by \$2 million.

Innovation

Tennessee established the Tire Environmental Fund in 2015. Upon the first retail sale of a new motor vehicle to be titled and registered in Tennessee, a flat fee based on the number of a vehicle's wheels is assessed. The fee goes into the fund, which is used for projects creating or supporting beneficial end uses for waste tires. The purpose of the Tire Environmental Act Program is to select and fund projects that best result in beneficial uses for waste tires. Projects

must qualify for one of three categories: tire processing/recycling, tire-derived material use, or research and development. Since 2015, grantees have been awarded almost \$4.5 million, and approximately 3.6 million tires or nearly 42,476 tons of scrap tires have been diverted from landfills. The tires are repurposed for use in rubberized asphalt, tire-derived aggregate, tire-derived fuel, granulated rubber porous flexible pavement, and other beneficial end uses that result in tires being diverted from landfill for a higher and better use.

Recently, TDEC today announced a grant of \$53,750 for Montgomery Bell State Park from the program to create a hard surface trail using flexible porous pavement. The trail will be near many of the park's recreational facilities and will connect the campground with the playground and ball field. The trail's main purpose is to provide a safe exercise space. The project will use enough crumb rubber to recycle several thousand tires in the process. The plans at Montgomery Bell follow a Tires to Trails project at T.O. Fuller State Park in Memphis and continue a partnership between Tennessee State Parks and TDEC's Office of Sustainable Practices to beneficially reuse tires while enhancing recreational opportunities in the parks.

Furthermore in 2021, TDEC honored Warriors' Path State Park in Kingsport as its top park in the state for innovation, part of the 2021 Tennessee State Parks Awards of Excellence. The park staff created and built the Cedar Ridge Hammock Campground after the closure of the park's primitive campground for new construction. The campground contains four sites built in a once privet-covered area. Each site was constructed with recycled, reused, or repurposed materials. The entire space cost the park only the installation of a water hydrant. Volunteers and park staff all made contributions in the form of support, labor, and ideas. Additionally, the campground features hammock posts constructed from cedars lost in a winter storm, picnic tables salvaged from dilapidated stone bases, benches constructed with components from rusted grills, fire rings made from leftover trail projects as well as river rock and even lantern hooks from scrapped grill handles from old fire pits. Cedar Ridge Hammock Campground opened in 2021 and has already served hundreds of guests. Recycling bins have been placed at the campground entrance. Other improvements to the area include a worm farm for composting organic waste from the campground, a group space, and walking trails to the nearest bathhouses with ample parking nearby.

Lastly, TDEC recently announced it is partnering with electric vehicle (EV) automaker and automotive technology company Rivian to install Rivian Waypoint EV charging stations at Tennessee State Parks. The goal is to have charging stations available at all 56 state parks, depending on the availability of electricity and planned future park upgrades. Rivian will oversee the design and installation of the Level 2 chargers, which are compatible with all EV models currently on the road. The open-network chargers can provide up to 11.5 kilowatts of power, enabling EV drivers to top up on miles while enjoying a day trip or an overnight campout. EV charging at Tennessee State Parks will initially be free and drivers will be able to easily monitor their vehicle's charging session via the Rivian app. Any potential future cost to drivers may be dependent on system wide utilization to recover electricity costs. In addition to overseeing design and installation, Rivian will provide any necessary utility upgrades associated with the charger installation at no cost to the state or taxpayers. Rivian will also cover all network access fees, equipment service and maintenance for 10 years. Under the estimated timeline, Rivian will begin

site surveys and engineering over the summer, with installation beginning as early as Fall 2021 and stretching into March 2022.

Recommendations to Raise the Grade

In order to raise the grade, the Park system needs to:

- Continue to use funds for the elimination of deferred maintenance needs.
- Invest in capital projects that would replace or significantly renovate facilities with large maintenance needs.
- Work to establish additional parks as needed once existing maintenance needs are stabilized.

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Rail: C

Executive Summary

Tennessee has a total of 34 railroads, including 6 Class I rail lines with a total track mileage of 2,133 and 23 Class III rail lines with a total track mileage of 806. Memphis is the third largest freight rail center in the nation. Freight volumes transported on tracks in Tennessee are forecasted to grow 130% by 2040 when compared to 2012. The state added supplemental track mileage with new short-line and corridor capacity improvements, but this support is not sufficient when compared to the population increase and the demand growth in rail freight movement. One study showed varying infrastructure conditions on Class I and Class II track operations: an estimated 64% and 26% of tie conditions rated as sufficient, respectively, per U.S. Track Class Regulations. The same study determined 41% of mileage examined within the state must be upgraded to accommodate heavier rail cars. The main passenger rail in the state operates on a rail line owned by CN, where Amtrak riders will benefit from a \$55 million redevelopment project at Memphis' Central Station.

Introduction

Tennessee has a total of 34 railroads, made up of 6 Class I with a total track mileage of 2,133 and 23 Class III with a total track mileage of 806, as seen in Table 1¹ Class I railroads are defined as railroad which generate more than \$943.9 million in annual operating revenue, Class II generates between \$42.4 million and \$943.9 million, and Class III generates less than \$42.4 million²

Table 1. Tennessee Railroads (TDOT, 2019)

Tennessee	Number of Railroads	Track Mileage
Total	34	2940
Class I	6	2133
Class III	23	806

There are 7 Class I railroads in the United States and 6 operate in Tennessee: CSX Transportation (CSX), Norfolk Southern (NS), Canadian National Railway (CN), Burlington North Santa Fe Railways (BNSF), Union Pacific (UP) and Kansas City Southern (KCS). CSX, CN and NS have more railroad miles in the state, while BNSF, KCS, and UP have less than 20 railroad miles independently within the state. Table 2 displays the Tennessee Class I operating railroads broken down by route mile. There are 23 Class III, or short-line, railroads, which total approximately 25% of Tennessee's total rail mileage. Tennessee's total track mileage is 2,940 miles, and the city of Memphis, TN has the third largest rail center in the nation¹When considering tonnage, rail ranks second for largest transportation modes in the state

¹ (TDOT, 2019).

² (Surface Transportation Board, 2022).

Table 2. Tennessee Class I Operating Railroads Breakdown by Route Mile (TDOT, 2019)

Railroad	Operated	Owned	Operated Under Lease	Operated Under Contract	Operated Under Trackage Rights
BNSF	137	17	-	-	127
CN	161	161	-	-	-
CSX	989	827	15	2	146
KCS	5	5	-	-	-
NS	827	662	136	-	46
UP	14	9	-	-	5

Freight

Tennessee is one of the most important freight rail hubs in the United States, where the state rail transports over 200 million tons of freight yearly³ According to the Association of American Railroads for 2020, Tennessee was tied for number nine, when ranked by state, for the number of freight railroads. When considering total rail miles by state, excluding trackage rights, Tennessee ranked 26th overall. 15.2 million tons and 458,400 carloads of rail traffic originated in Tennessee during 2019, while 26.1 million tons and 615,200 carloads of rail traffic terminated in Tennessee during that same year ⁴The tonnage of freight is expected to grow 92 percent by 2040, to approximately 148.9 million tons inbound and outbound. 2040 projected rail volumes show that several rail lines will experience significant levels of congestion. Without an improvement in the operational performance of freight networks, congestion will increase significantly over the long-term horizon and increased freight volumes will increase vehicle weight of the transport thus deteriorating the rail faster requiring further maintenance.

Passenger

In the state of Tennessee, only one Amtrak route for rail currently passes through the state, which travels from New Orleans, LA to Chicago, IL using CN railways. Amtrak has two stations in the state, one in Newbern and the other in Memphis. Central Station, in Memphis, was recently redeveloped through a \$55 million redevelopment project, completed in 2019 (TDOT, 2019). Currently, TDOT does not own or operate any of the intercity or commuter passenger rail services. For the Amtrak service in Tennessee in 2019 – the last year before the COVID-19 pandemic – approximately 64,851 passengers passed through the state boarding and detraining, which was a decrease compared to 2018 of 73,758 passengers (Rail Passengers Association, 2020). Amtrak average fare in Tennessee totaled \$81.00 and the average yield per mile was 20.6¢. Amtrak spent \$6,661,332 on goods and services in Tennessee in FY19 (Amtrak, 2020).

Figure 1. Tennessee Amtrak Routes

³ (Emert & Skinner, 2021).

⁴ (Association of American Railroads, 2019)



As of February 2022, there is a push for more Amtrak lines in Tennessee which has the support of Memphis Tourism officials who are advancing the idea to study the expansion of Amtrak service to include Nashville and other cities in the Volunteer State. Last year, Amtrak announced a vision to add a passenger line connecting Atlanta and Nashville which could become a reality with the help of the \$1 trillion infrastructure bill. Currently, the only one way to get from Memphis back to Nashville is one interstate road.

The Middle Tennessee Regional Transportation Authority (RTA) started the Music City Star, typically known as WeGo Star, which is a public transit system for residents to travel between Lebanon and Nashville (Nashville MTA, 2022). As of August 2020, 8 new “used” rail cars were put into service, due to the existing rail cars reaching the end of their useful life⁵. Also in 2020, other upgrades included improvements for station platform and parking lot, as well as a simplified fare collection system. There has been recent discussion to extend the commuter rail to Clarksville, TN.

Capacity & Condition

With the population continuing to grow in the state of Tennessee, improvements to the rail system can help further develop urban areas by providing a different mode of transportation, as well as, helping the demand for freight volume increase. Freight moved via trucks will remain as the preferred form of freight transportation across the country due to several factors. However, with population growth in Tennessee, tonnage shipped on, to and through Tennessee via rail will only continue to increase. By 2040, railroads within the state are estimated to carry more than 555 million tons of freight, a growth of nearly 130% when compared to 2012, valued at \$715.8 billion.¹

In 2020, there was a study performed for TDOT entitled *TDOT Short Line Railroad Needs Assessment*⁶. Moffatt and Nichol assessed 817.2 miles of rail and an estimated 63.86% and 25.54% of the tie conditions were sufficient for Class I and Class II track operation, per U.S. Track Class Regulations. An assessment was also performed on rail replacements to support 286,000-pound gross vehicle weight service cars (286K GVW) by rail size. The study determined that 59% of rail on short-lines are satisfactory for 286K GVW operation and 41% are non-satisfactory for 286K GVW operation.. The same study also assessed 518 bridges in the

⁵ (Nashville MTA, 2022)

⁶ (Moffatt & Nichol, 2020)

state and found approximately 38.8 percent are in overall good condition, 44.0 percent in fair, and 17.2 percent in poor (Moffatt & Nichol, 2020).

Operation & Maintenance

According to the Transportation Statistics Annual Report 2021, system-wide average terminal dwell time increased for the following Class I railroads, CSX, KCS, NS and UP, where system-wide average dwell time minimally decreased for BNSF and CN, when comparing 2020 with 2021 (U.S. Department of Transportation, Bureau of Transportation Statistics, 2021). Rail congestion also has become an issue when considering the growth in freight demand. Rail congestion will lead to overcrowded corridors and terminals, as well as the need for more frequent rail maintenance due to faster deterioration from the increase in volume.

According to the Association of American Railroads, in 2019 there were 3,305 freight rail employees in the state, where the average wages and benefits per employee were \$136,140 (Association of American Railroads, 2021).

General rail maintenance in Tennessee for Short Line Railroads typically consists of thermite welding and wayside weld lubricators⁶In CN's 2022 Capital Plan for U.S. Investments, CN will invest \$30 million in Tennessee for a maintenance program where there will be an installation of nearly 38,000 new railroad ties, 16 road crossing surface rebuilds and maintenance work on bridges, level crossings, culverts, signal systems and other track infrastructure⁷

TDOT has a Rail Safety and Inspection Office that enforces state laws where at-grade rail-highway crossings must be maintained in good condition by the railroads (TDOT, n.d.). TDOT also has a partnership with the FRA where they perform inspections on the railroad track, handling of hazardous materials, railroad signals and train control, and railroad operating practices (TDOT, n.d.). The departments railroad inspectors also mandate Tennessee state laws regarding the railroads.

TDOT additionally has the Office of Rail Engineering. Over \$5 million in funds are received yearly in the Section 130 program. This is a federal aid program authorized by United States Code Title 23, which provides dollars to address the greatest risk at railroad crossings in the state (TDOT, n.d.). The FRA maintains the national crossing inventory database. The Office of Rail Engineering maintains a crossing inventory database which is used to update the national database and help prioritize crossings for projects.

Funding

When considering the future investment in freight rail for Class I railroads, most of the funds will come from the private sector. Class I railroads pay for their own infrastructure improvements since they are privately owned. For Class III railroads, the majority is paid for by revenue per ton mile.

⁷ (Canadian National Railway Company, 2022).

Funding at the federal level consists of Formula Funding Programs and Competitive Federal Funding Programs. The Formula Funding Programs and Competitive Federal Funding Programs that are applicable in the state of Tennessee are show in Table 3.

Table 3. Funding at the Federal Level

Formula Funding Programs	Competitive Federal Funding Programs
Highway-Railroad Grade Crossing Program (Section 130 Program)	Fixed Guideway Capital Investment Grants-Section 5309 (New Starts or Small Starts Grants)
Urbanized Area Transit (Section 5307)	Transportation Investment Generating Economic Recovery Discretionary Grants Program (TIGER)
State of Good Repair Formula Grants (Section 5337)	United States Department of Agriculture Programs
Congestion Mitigation and Air Quality Improvement Program (CMAQ)	-
FAST Act /Bipartisan Infrastructure Law Freight Funding	

One of the state revenue sources for rail improvements is the Transportation Equity Fund, also known as Short-Line Railroad Rehabilitation Program. The tax revenue reported by the Department of Revenue for FY 2020-2021 for rail was \$ 3.98 million out a total of \$23.8 million(TDOT, 2021). This amount is provided to the Short Line Railroads within the state for railroad improvements.

TDOT also offers Railroad Grant Programs, which entails Short Line Railroad Preservation Grants, where the program is setup to preserve rail service to the public and grow rail connectivity to destinations along existing rail corridors (TDOT, 2022). The Governor presented \$85 million in additional funding for the Short Line Railroad Preservation Grant program in the Fiscal Year 2022 Tennessee General Appropriations Bill (TDOT, 2022).

As of August 2022, there has been 23 awarded Railroad Project Bids from TDOT and two Bid Advertisements (TDOT, 2022). In 2021 TDOT awarded bids for 12 projects, totaling the amount of \$10,974,689.20. In 2020 TDOT awarded bids for 24 projects, totaling the amount of \$12,990,141.21 (TDOT, 2022).

The Bipartisan Infrastructure Law will supply Federal funding for rail improvement projects for the next five years (USDOT FRA, 2022). Overall, the law has set aside \$102 billion for rail funding, which consists of \$66 billion from advanced appropriations and \$36 billion in authorized funding. When considering this funding for rail in the state of Tennessee, the goal is to grow and improve passenger rail, as well as increase freight rail efficiency and safety (USDOT, 2022). Tennessee can also apply for competitive grants, such as \$10 billion for rail improvement and safety grants and \$5.5 billion for grade crossing safety improvements.

Future Needs & Innovation

Through passenger and freight rail, The Southeast Corridor (SEC) Commission is organizing the effort to join states across the Southeast region. The SEC expands from Washington, DC, through Virginia, North Carolina, South Carolina, Tennessee, and Georgia, to Florida (Southeast Corridor Commission, 2022). A possible Amtrak connection between Roanoke, TN and Bristol, VA was identified by the 2014 Virginia Statewide Rail Plan.

The state of Tennessee is evaluating and examining the possibility of the high-speed rail. With recent advancements and investments in the high-speed rail, the FRA continues to develop long term regional rail plans.

Resiliency & Public Safety

Railway systems will only become more difficult to operate safely and efficiently due to the increased demand for transportation needs. With an increase in unpredictable events, such as, disasters and disruptions, railway network delays and closure will further disrupt the movement of goods and lead to further congestion.

Recommendations to Raise the Grade

- Development of new corridor capacity to decrease performance delays due to demand increase on freight rail lines.
- Update and maintain short-line railroads to accommodate 286K loads.
- Develop passenger rail corridors linking major cities.
- Expanding existing freight rail service to new customers by expanding the network of short-line railroads.
- Provide rail service to new major developments, such as Blue Oval City Ford Manufacturing facility in Stanton, TN.
- Further investigate infrastructure funding sources that are available.

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Roads: C

Introduction

Tennessee has over 95,000 miles of highway that are critical for residents, visitors, and the movement of approximately \$812 billion of goods shipped annually to and from the state. Tennessee’s population has grown by 9% since 2010. This steady growth has in turn increased the total vehicle miles travelled (VMT) by 7.4% since 2016. Increased vehicular traffic throughout the state has led to increased pavement deterioration, congestion, and traffic fatalities. In 2021, 50% of interstates and 44% of state routes were in good condition. However, deferred maintenance and funding shortfalls have resulted in declining pavement conditions over the past five years: the state’s average pavement Quality Index dropped from 4.2 in 2016 to 3.9 in 2021 for interstates; 3.6 to 3.3 between those years on state surface roads. Tennessee’s Traffic fatality rate in 2021 was 1.60 per 100 million vehicle miles travelled, compared to the national rate of 1.33. 1,325 residents died on Tennessee roads in 2020: an unacceptable number most effectively reduced by safer design and engineering of roads.

Condition

The Tennessee Department of Transportation’s (TDOT) Pavement Management section utilizes the Pavement Quality Index (PQI) as a metric to evaluate the condition of pavement surfaces on state-maintained highways. PQI is based on a scale from 0 to 5, with 5 indicating perfect condition. TDOT’s 2021 pavement management system (PMS) report (6) defines the state of good repair for its pavements as well as its performance objectives for both interstates and state Highway Routes (Tables 1 and 2). Table 3 shows the results of TDOT’s pavement assessment for 2021.

Table 1 - TDOT's Definition of Pavement State of Good Repair

System	Poor	Fair	Good
Interstates	PQI < 2.0	2.0 <= PQI <= 4.0	PQI > 4.0
State Routes	PQI < 2.0	2.0 < PQI <= 3.5	PQI > 3.5

Table 2 - TDOT's Pavement Performance Targets

System	Good	Poor
Interstates	> 50%	< 0.5%
State Routes	> 45%	< 0.5%

Table 3 - 2020-21 Performance Results for Interstates and State Routes

System	Quality			Average PQI
	Good	Fair	Poor	
Interstates	50.43%	49.53%	0.04%	3.946
State Routes	44.26%	52.15%	3.59%	3.340

From the data collected by TDOT, interstates are marginally meeting their targets for the State of Good Repair. However, figure 1 indicates that the PQI for Interstates has been decreasing since 2016 and is likely to continue to decrease given the additional wear caused by projected traffic volume increases. The pavement condition of state routes in Tennessee do not fare as well as its

interstates, as evidenced by the average PQI clearly failing to meet the desired target of less than 0.5% of pavements being in poor condition. TDOT’s annual pavement assessment only covers state operated roads, which accounts for around 15% of all roads in Tennessee. The remaining 85% are locally owned and maintained. Thus, pavement assessments on these roads are done in accordance with governing local (City or State) procedures and Protocols. Information on pavement quality of local roads in Tennessee is limited. Nevertheless, Tennessee’s road conditions nationally rank highly. Sources such as the Reason Foundation’s 26th annual ranked Tennessee 9th and 10th nationally for overall pavement condition for urban and rural roads, respectively. Consumer Affairs also ranked Tennessee 11th in the nation for combined rural and urban pavement quality (25).

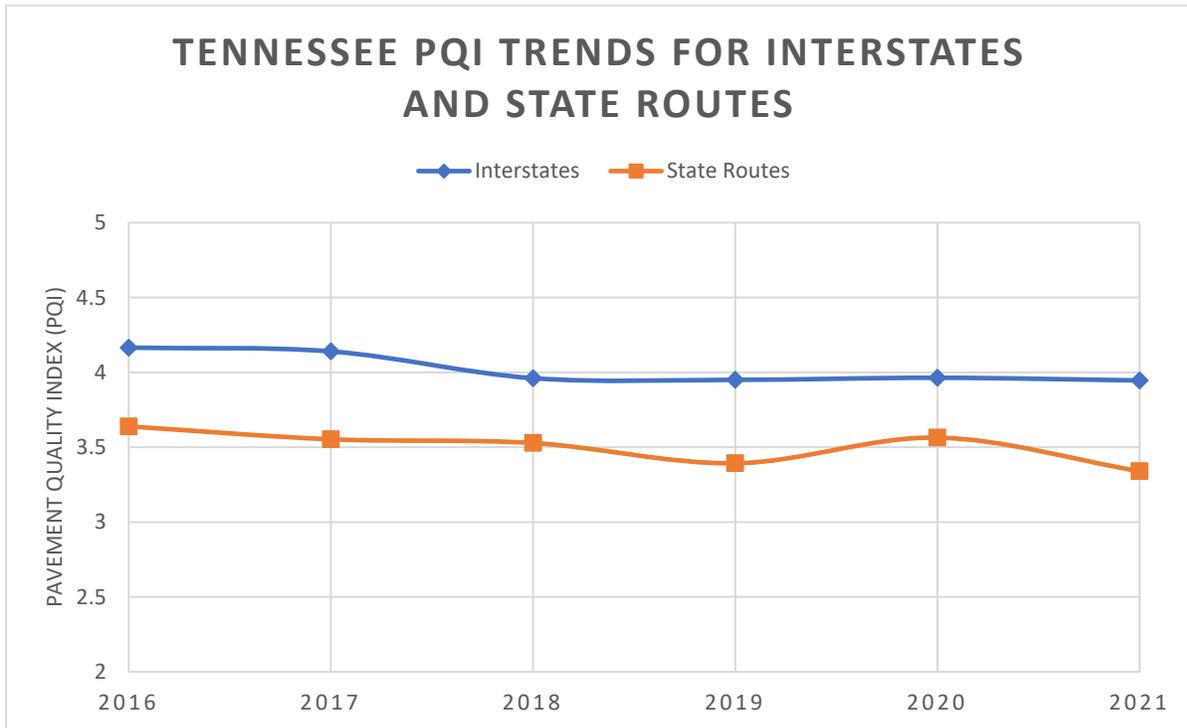


Figure 1- PQI Trends in Tennessee (2016-2021)

Capacity and Future Needs

Tennessee’s economic and population growth have led to an increase in the demand for vehicle travel on the state’s major roadways. This increase in traffic demand is predicted to put additional strain on Tennessee’s roads and will lead to increased congestion as well as a reduction in the Level of Service (LOS). TDOT identifies that traffic congestion is a major and growing problem in Tennessee, resulting in serious inconvenience and frustration to motorists through increased delays, negative impacts to trade and commerce, increasing pollution, and wasted energy through additional fuel consumption. Tennessee’s population surpassed 6.9 million in the 2020 census (7), which is a 9% increase since 2010. Increasing congestion has led to noticeable increases in travel time, particularly in the state’s large metropolitan areas. Nashville is the worst area in the state for traffic congestion, with the average driver losing 33 hours each year to congestion during pre-pandemic conditions, according to 2018 data collected by INRIX (8).

Chattanooga drivers lost 21 hours a year to congestion, Memphis drivers lost 17 hours a year, and Knoxville drivers lost 12 hours a year. Traffic congestion costs both time and money in the form of increased vehicle operating costs, crash costs, and fuel consumption. Table 4 summarizes costs incurred by both motorists and cities due to congestion in the four largest urban areas in Tennessee.

Table 4 – 2018 Annual Congestion Costs in Tennessee

Region	Cost to Drivers	Cost to Region
Nashville	\$1,469	\$1.2B
Chattanooga	\$946	\$293M
Memphis	\$846	\$175M
Knoxville	\$673	\$94M

Congestion is an inevitable consequence to Tennessee’s steady population growth. Increased traffic volume will continue to degrade the LOS on the state’s roads. The Truck Travel Time Reliability (TTTR) index is a metric used to assess the reliability of highway travel times for trucks moving freight. The TTTR is the ratio of the 95th percentile travel time to the 50th percentile time. Higher values indicate a higher uncertainty in travel time. The FHWA reported an Interstate TTTR Index of 1.25 for Tennessee in 2021, which has remained relatively stable since 2017. This relatively low TTTR Index indicates the Tennessee has an overall reliable travel time for its interstates (24).

Recent findings by TDOT’s Forecasting Office (18) indicate increases in the v/c ratio, a decrease in LOS, and increased delays, particularly in the state’s four largest metropolitan areas. For example, Nashville is expected to have v/c ratios approaching 1.0 for segments of I-24 and I-65 by 2040, indicating extreme levels of congestion (LOS F). Additional findings by the office indicate that the state’s current road network is unable to meet future needs, which further emphasizes the need to improve the state’s transportation infrastructure.

Operation & Maintenance

TDOT is actively engaged in identifying problems in its road network by employing the help of the primary road users. TDOT’s online Maintenance Request Form allows motorists to report potholes and request other necessary roadway maintenance, allowing TDOT to quickly identify problems and initiate a timely response (9).

TDOT’s maintenance efforts appear to be effective as indicated by the Reason Foundation’s annual report, which ranked Tennessee's urban pavement condition in the top 10 in the nation for both interstates and major arterials (10). Despite this, TDOT appears to be struggling to keep to its budget for pavement management. TDOT’s 2022 Transportation Asset Management Plan (TAMP) biannual consistency determination report (June 1, 2021 to May 31, 2022) indicates the agency had an budget of \$945 Million for pavement maintenance, preservation, rehabilitation, and construction, (11). However, actual reported spending for the 12-month period was around 1.3 billion. The difference between the proposed and actual pavement spending indicate that proposed pavement budgets may be insufficient in maintaining pavement condition for the future let alone allowing for improvement to meet the state of good repair goals.

Safety

In 2021, the Tennessee Department of Safety and Homeland Security reported that there were 1,325 traffic fatalities in Tennessee, which was a 9% increase from 2020 (12) (Figure 2). This appalling figure is unacceptable and needs to be addressed.

Traffic deaths are functions principally of the design and engineering of the road and public space nearby, such as (the lack of) sidewalks. The funding and design of roads, therefore, offer the best opportunity for eliminating traffic deaths.



Of the 1,325 fatalities in 2021, 556 occurred on rural roads (light blue), and 769 occurred on urban roads (dark blue). In 2021, Tennessee had a combined rural and urban fatality rate of 1.60 (per 100 million VMT), which is higher than the national average of 1.33 and ranks Tennessee 40th overall in the nation (13). A 2018 report by the national transportation research group TRIP also found that Tennessee has one of the highest rural fatality rates, with 2.42 deaths per 100 million VMT compared to the national average of 2.00 (14).

The Tennessee Highway Safety Office (THSO) is the division that advocates for traffic safety in Tennessee. THSO works alongside the National Highway Traffic Safety Administration (NHTSA) to implement federally funded programs that aim to reduce fatalities on Tennessee's roadways by changing roadway engineering that affects user behavior. Education and enforcement of traffic safety laws are helpful supplements. THSO continues to work toward the nation's "Towards Zero Deaths" plan: a commitment to reduce deaths to zero and minimize serious injuries. A similar effort — Vision Zero — has been adopted by cities such as Nashville. Vision Zero refocuses the paradigm of planning and implementation away from ineffective public awareness efforts and toward data-proven interventions like narrowing vehicle lanes and reducing pedestrian crossing distance with curb extensions.

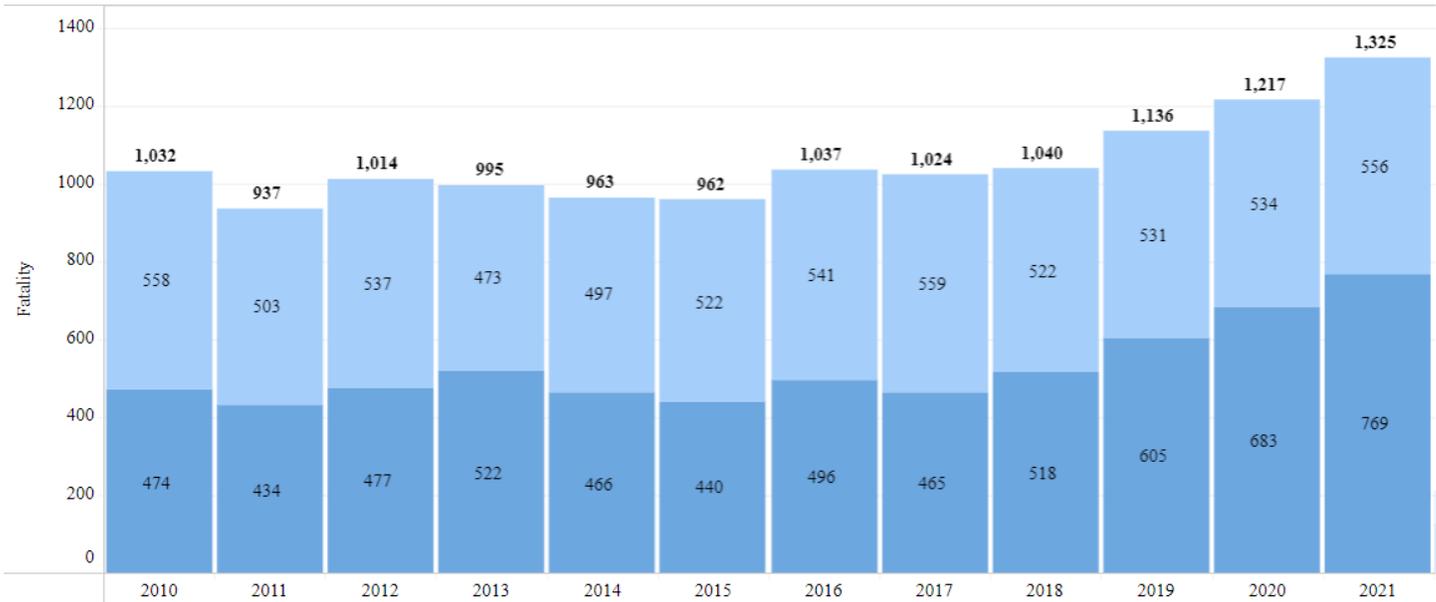


Figure 2- Traffic Fatality Trends, TN Department of Safety and Homeland Security

As mentioned, roadway design is the primary factor determining the likelihood and severity of crashes. User behavior – behind the wheel, at the cockpit of a bike, or even walking from the bus stop – is determined by that engineering. The appropriate safety projects differ by context and crash type. Lane Departure and Roadway Departure were the two most frequent crash types on TDOT roads from 2014-19. Rumble strips made of asphalt depressions reduce those crashes in rural areas and on higher-speed roads. TDOT has engaged in several such projects, including constructing guardrails, adding rumble strips, adding pedestrian crossings and upgrading their design, and improving intersection design. Bike lanes, especially protected bike lanes, improve the safety of roads for all users – slowing motorists and reducing pedestrian crossing distance.

Technology can be helpful to traffic safety. Safety features on motor vehicles such as Automatic Emergency Braking (AEB) assist when those Advanced Driver Assistance Safety (ADAS) systems operate properly. Some ADAS systems will re-position a vehicle headed into the next lane or onto the shoulder, addressing the departure crashes mentioned above. However, technology has limitations. Intelligent Transportation Systems (ITS) do not change the need to re-design roads so that the mistakes of people driving, biking, and walking are not deadly.

Resilience

Resilience refers to the ability of a system to recover from both unexpected and anticipated effects. A resilient highway system is one that can anticipate, operate, and recover from the impacts of external disruptions, accidents, natural incidents, or deliberate attacks.



TDOT has implemented and expanded many programs and policies to provide resiliency to Tennessee's roads. Tennessee's intelligent transportation system, SmartWay, provides real-time up-to-date traffic information that is accessible to motorists through web-based apps, radio, and mobile phones. SmartWay uses data collected through traffic control centers to inform motorists of accidents, lane closures, construction, and road conditions (flooding, ice, snow, etc.). SmartWay also incorporates 475 cameras in Tennessee's four major metropolitan areas to provide livestreaming of traffic on the state's major roadways. In addition, dynamic message signs alert drivers about travel times and delays, while TDOT's HELP program's patrol trucks provide highly trained accident clearance crews that clear incidents as efficiently as possible to minimize the effects of a loss of capacity to roadway users. These programs showcase TDOT's innovative approach to providing resilience, which adopts advanced technology to provide the most efficient and intelligent transportation network possible to Tennessee and its road users.

A good case study of the resilience of Tennessee roads is the repairs conducted on the Interstate 40 Hernando DeSoto Bridge from May to August 2021 in Shelby County in the Memphis area. A fracture in one of the bridge members required that the bridge be closed until extensive repairs were completed. Realizing that the area experiences some of the highest truck traffic percentages in the nation, shipping goods across the state and beyond, TDOT in association with the Arkansas Department of Transportation (ARDOT) worked to create a diversion to I-55 (the next bridge south of I-40) to allow vehicles to cross the Mississippi at the least cost to drivers in terms of delay. TDOT incorporated the use of dynamic massaging boards to provide delay information and published anticipated hour-by-hour, day-by-day delays during the construction to inform drivers. Though undoubtedly there were delays, this case study is a testimony to the resilience of Tennessee's roadways to respond to unforeseen events and provide the most efficient response (15).

Funding

TDOT has a budget for FY 2022-23 of \$3.19 billion (Combined Federal and State), according to the State of Tennessee's budget report (16). This is an overall increase of \$802 Million from the 2021-22 FY. TDOT's budget has increased over the past several years, experiencing a 70% increase since 2016-17 (figure 3) . The budget is allocated among TDOT's five major divisions: Headquarters, Bureau of Administration, Bureau of Engineering, Bureau of Operations, and Bureau of Environment and Planning. Table 4 summarizes the allocated budget for each of these divisions. The Budget indicates that the Operations divisions will receive 70% of the department's budget. The Bureau of Operations is TDOT's largest division and conducts its primary operations, including road and bridge design, traffic engineering, construction, materials testing, maintenance, surveying, and safety.

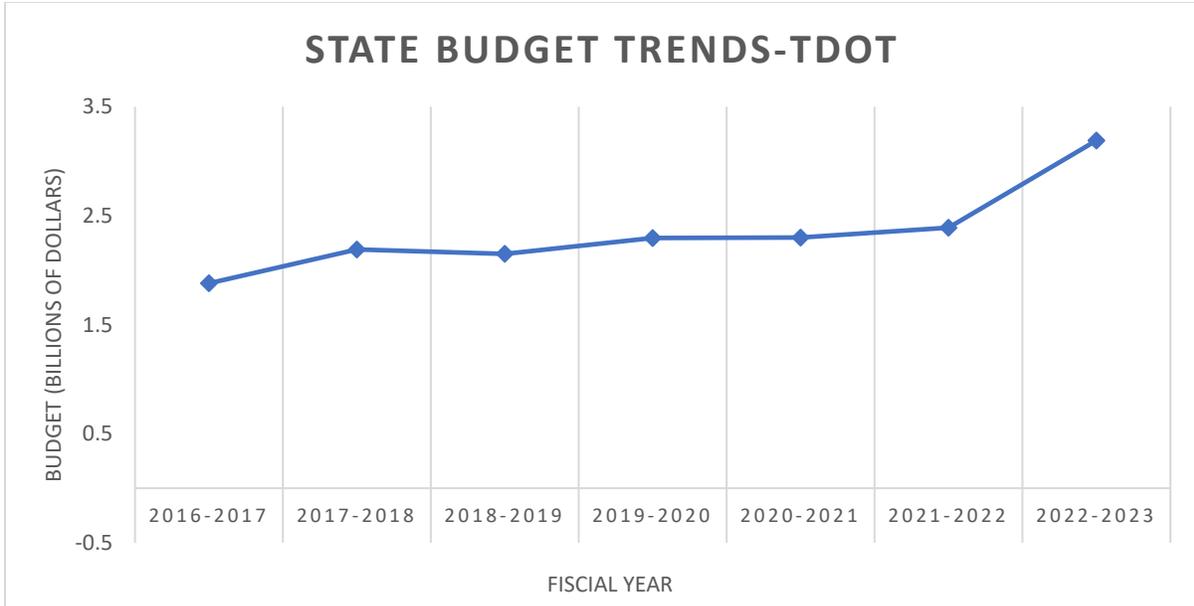


Figure 3- TDOT Budget Trends

Most of the additional funding (56.8%) will be collected from state funded programs. 42% of funds will come from the federal government. The remaining 1.2% comes from other sources. Furthermore, according to analysis by TRIP, the recently enacted Infrastructure Investment and Jobs Act (IIJA) signed into law by President Biden in November 2021 is expected to provide \$6.86 billion to Tennessee in federal funding over the next five years for investment in highway, bridge, and transit. This investment by the IIJA towards Tennessee’s roads will provide an additional \$1.42 billion to the state’s GDP each year.

Table 4- TDOT Budget for FY 2022-23

Division	Actual 2021-2022	Estimated 2021-2022	Base 2022-2023*	Cost Increase	Budget 2022-2023
Headquarters	\$94,253,200	\$116,819,100	\$68,298,400	\$3,500,000	\$71,798,400
Bureau of Administration	\$64,085,100	\$77,136,000	\$96,136,800	\$0	\$96,136,800
Bureau of Engineering	\$279,010,500	\$421,003,600	\$415,399,600	\$130,367,200	\$545,766,800
Bureau of Operations	\$1,503,025,800	\$1,742,395,900	\$1,742,125,200	\$480,132,400	\$2,222,257,600
Bureau of Environment and Planning	\$188,509,400	\$335,569,600	\$240,048,200	\$12,500,400	\$252,548,600
Total	\$2,128,884,000	\$2,692,924,200	\$2,562,008,200	\$626,500,000	\$3,188,508,200

* 2022-2023 Proposed budget after base appropriation reduction

State funding for roads in Tennessee is provided primarily by state highway user taxes. These taxes and fees are comprised of vehicle registration fees and a 27.4-cent-per-gallon gasoline tax

(26 cents/gasoline tax + 1.4 cents/gallon special petroleum fee) as of 2022. Tennessee has continued to adopt “pay as you go” (PAYGO) strategies for funding its highway program. This conservative approach means that funding for roads can only be sourced through dedicated revenue sources that include highway user taxes and federal funding. PAYGO has allowed Tennessee’s highway program to remain debt-free since the mid-1990s. Despite this, the state will need to search for new highway funding alternatives because reliance on a gas tax is unsustainable as vehicles become more efficient and oil prices become more volatile. Furthermore, the growth of electric vehicles and renewable energy sources poses a threat to this funding mechanism. In the future, the state will need to reevaluate its funding methods, including by shifting the focus towards assigning user costs in proportion to highway network use as measured by VMT.

TDOT acknowledges the generous \$626.5 million increase in funding from the 2022-23 base budget and has plans to invest additional funding towards several programs throughout the state, with \$266 million of the additional funding to be allocated to the State Highway Partnership Program, which will be utilized for infrastructure improvement projects across the state. Additionally, \$176 million will be allocated to interchange improvement projects in rural areas, which include ramp geometry improvements, road widening, and lighting improvements. The remainder of the additional funding will be distributed to several areas, including economic development projects, highway litter removal, the state’s transportation equity fund, and the Improving Manufacturing, Public Roads, and Opportunities for a Vibrant Economy (IMPROVE) Act, which will contribute to public road improvement projects (17). Tennessee is one of only five states with no transportation debt and the additional funding will continue to keep TDOT in a good financial condition and will allow for more projects to be initiated in the future to accommodate the growing needs of the state's road network.

Innovation

TDOT’s Traffic Operations Division is responsible for implementing programs to maximize the capacity and safety of existing systems. This division has continued to utilize technological innovations to achieve this goal as well as to adopt best practices for transportation systems management and operations (TSM&O) and collaboration with state and local agencies. TDOT’s SmartWay, HELP patrols, dynamic messaging boards, Traffic Management Centers (TMC), and social media platforms are some of the many technological innovations that TDOT uses on a daily basis to inform motorists of traffic conditions and to increase safety. The investment and maintenance of these systems is likely to increase as the demand for such systems rises with growing traffic volumes. TDOT should therefore ensure that necessary funding is allocated to these programs.

Recommendations

The Tennessee Section of ASCE offers the following recommendations for improving roadways in the state:

- Pursue additional funding by considering strategies such as levying taxes on VMT and special assessments on alternative-fuel vehicles.
- Implement policies at TDOT that weigh the safety and comfort of people walking and biking higher than other factors such as vehicle delay.

- At the state and county level, pass legislation that requires safety audits of roadways undergoing repaving and reconstruction, with a new design that improves safety.
- Continue to engage in programs and strategies to reduce Tennessee’s vehicular fatality rate.
- Document progress made towards the implementation of the 25-year Long Range Transportation Policy Plan.
- Develop and adhere to pavement maintenance schedules.
- Continue researching and applying new pavement preservation techniques.
- Continue the expansion of TDOT SmartWay across the state.
- Maintain up-to-date records and reports about Tennessee’s roadways.

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Solid Waste: C+

INTRODUCTION

Statewide, approximately 60 percent of municipal solid waste (MSW) is disposed in municipal sanitary landfills. With a fast-growing population, decision-makers in Tennessee must balance the regional benefits of waste disposal with localized harms: legal action has stopped expansion of landfills citing harms to adjacent communities, but long-distance waste removal is more expensive and generates regional climate harms. In 2019, Nashville was diverting only 18% of its solid waste away from landfills. Even if waste diversion increases, challenges attracting workers harm solid waste systems. In the City of Chattanooga, starting wages for waste drivers were increased by more than 40 percent, from just over \$31,500 to \$45,000. That allowed the city to restore recycling collection in November 2021 after halting it in July.

CAPACITY AND CONDITION

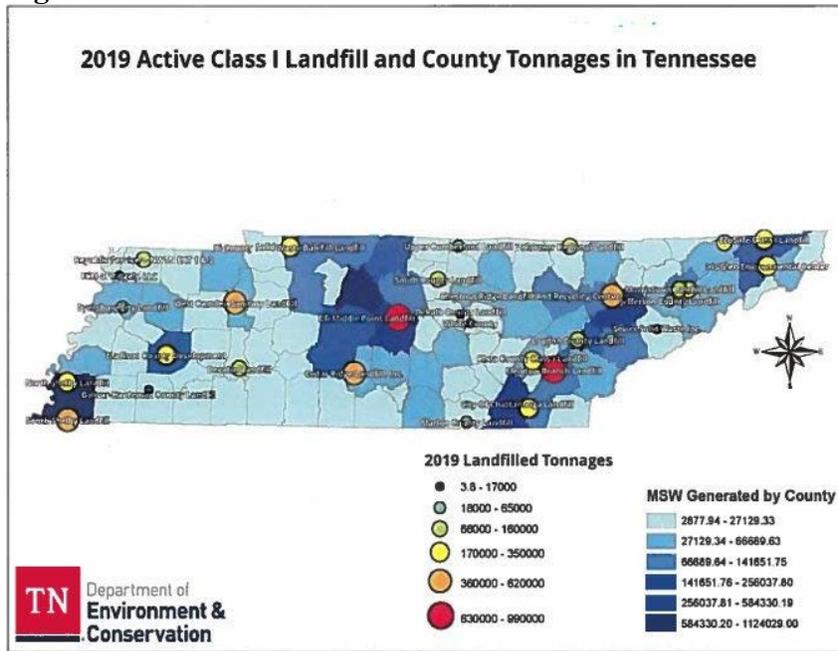
In 2019, there were a total of 48 permitted Class I landfills, of these 28 are active with 16 of these being privately owned (TDEC SWM Staff Memo 11/24/2021). Since Class II Landfills are dedicated to specific industries or manufacturers, all the Class II landfills are privately owned and will not be addressed in this report. Class III (III/IV) landfills are predominantly owned and operated by the public sector. Of the 57 Class III C&D landfills, 42 are owned and operated by the public sector and 15 are owned by the private sector. Municipal solid waste management in Tennessee has transitioned over the last 30 years from being primarily managed by city and county governments to primarily being managed by the private sector. This shift has resulted in construction of Class I municipal sanitary landfills with sufficient total capacity to dispose of MSW for at least the next 10 years and likely up to 25 years, based on 2019 data. Please see Figure 1 on the next page.

In Tennessee, as well as other states, recycling and composting operations, have helped divert trash from landfills. Recycling programs have been tried in the State with varying degrees of success. The primary driver for recycling program success is a ready market for the recycled materials. The recycling markets are driven by economic factors and tend to fluctuate. If there is no demand for the materials collected in recycling programs, the net result is that the materials end up in MSW Class I landfills.

Given a recently rejected lawsuit in 2021 for the expansion of a landfill in Nashville to the protracted political battle over closing the landfill in Murfreesboro, the urgency of Middle Tennessee's trash crisis has increased in intensity in recent months. approaches that favor more recycling, more composting. In 2019 it was reported that Nashville was diverting only 18% of its solid waste away from landfills. Their goal is to increase that to 90% in the next 20 to 30 years. How quickly Nashville pursues a more progressive recycling and composting plan affects the Middle Point Landfill in Murfreesboro, where Nashville and Rutherford County send the majority of its trash. A more aggressive approach to recycling construction materials affects the Southern Services landfill in north Nashville, the only such facility within a 40-mile radius. Addressing solid waste policy with a unified approach would put all of Middle Tennessee on a more sustainable waste disposal future. In the meantime, landfills in the Nashville area are nearing their limits. Nashville has increased, rather than decreased its reliance on landfills, even accounting for the city's explosive population growth over the past decade. In 2020, the city was

sending 901,000 metric tons to landfills or 1.29 per person. Adding to the city’s long term challenges is that local officials have control over only 11% of the landfill waste and four percent of recycling waste generated by businesses and residents. Waste and recycling from outside the urban services district designation is managed privately as is all commercial waste from construction sites, restaurants, hospitals, factories and offices. An analysis of Nashville’s trash habits estimates that 30% of the city’s waste could be diverted to composting facilities, drastically reducing its reliance on landfills.

Figure 1



Currently, the Central Tennessee Regional Solid Waste Board, which oversees how waste is handled in Rutherford County, Tennessee, passed a resolution that would prohibit the acceptance of trash from outside counties. The resolution will prevent waste from nine counties from going into the Middle Point Landfill, operated by Republic Services, Phoenix. About 70% of the waste that goes into the Middle Point landfill is from outside counties. The biggest contributor to this statistic is Davidson County, which contributes to about 46% of the waste being accepted at the landfill. Davidson County is followed by Sumner County, which contributed 4.29%, Wilson County at 4.04% and Williamson County at 3.29%. Accepting the outside waste has created hazardous chemical reactions at Middle Point, forcing sections of the landfill to close prematurely.

Given the fact that there will be a developing need for landfill capacity in middle Tennessee, there needs to be additional landfills permitted in this region to avoid the additional transport costs to dispose of waste in the neighboring east and west regions. The primary impediment to permitting new landfills and waste management facilities in Tennessee is the Jackson Law which authorizes any local government authority to prohibit siting a landfill or waste management facility in the area under their jurisdiction. The only requirement of a local government to use this authority is to officially adopt the Jackson Law.

FUNDING

Solid waste management programs in the State are funded through grants from TDEC. The Tennessee Solid Waste Management Act (SWMA) of 1991 established a waste reduction goal to divert 25% of the waste disposed in Class I landfills by 1995. Subsequent amendments to the SWMA by the State Legislature deleted the target date and established an ongoing goal to reach 25% diversion. This Act also established the Solid Waste Management Fund to support waste avoidance, waste reduction and recycling, waste processing with energy recovery, incineration without energy recovery, and by composting. These funds are also to be used to manage the collection and proper disposal of Household Hazardous Waste. To accomplish this goal, TDEC has established technical assistance programs, education programs to enhance diversion and resource recovery. Funds to accomplish these goals are generated by a \$0.90 surcharge on each ton of MSW disposed or treated in landfills or management facilities. TDEC tracks waste reduction through annual reports prepared by counties and cities and assists poorer rural communities by offering grants but the state has yet to achieve its 25% diversion goal. Sevier County in Tennessee is home to one of the best run compost facilities in the world and serves as a model for other states and countries worldwide. This approach to waste management could be duplicated in larger counties and/or waste management regions to help achieve the diversion goal.

OPERATION AND MAINTENANCE

The COVID-19 pandemic affected many sanitation workers around the U.S. such that some cities have had to delay or suspend garbage or recycling pickup. The slowdowns have caused trash buildups leaving cities such as Nashville so shorthanded they have temporarily stopped collecting recyclables, yard waste or oversized junk to focus on more municipal solid waste. To keep the trash from piling up, some municipalities are hiring temporary workers or contracting with private haulers. Some are offering signing or retention bonuses or pay raises. For example, in the City of Chattanooga, starting wages for drivers were increased by more than 40 percent, from just over \$31,500 to \$45,000. That allowed the city to restore recycling collection in November after halting it in July and continue routine pickups despite the omicron surge.

FUTURE NEEDS

Based on population growth projections in Figure 2, prepared by the University of Tennessee, the population of Tennessee is projected to grow from about 7 million in 2022 to about 7.5 million in 2032. According to the EPA, the per capita waste generation rate in the U.S. ranges between 4.5 to 5.0 lb/person/day. For this assessment we have chosen a high-end value of 4.9 lb/person/day. At this per capita generation rate, the 2022 MSW produced per year is estimated to be 17,143 tons per day (6,257,195 tons/yr) with the projected 2032 generation rate being 18,335 tons per day (6,692,275 tons/yr). The TDEC landfill remaining life survey indicated that landfills with

over ten years of remaining life have over 135.28 million tons of capacity which would suggest that there remains sufficient capacity for over 20 years.

From a statewide perspective there is “in place” MSW disposal capacity that will last for at least 20 years.

However, when considering the three grand divisions of the state East, Middle and West, one of the three is projected to fall short. See Figure 3. Central Tennessee is experiencing unprecedented population growth and is limited in its ability to expand disposal capacity. However, the West and East Divisions can easily absorb the additional capacity loading. The solution here is to haul the waste

for disposal to the other grand division. The larger private sector waste management companies have indicated that this solution is economically feasible.

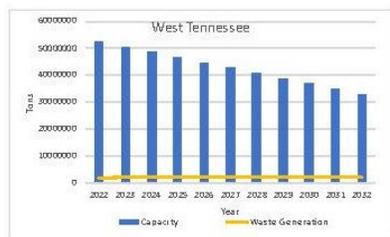
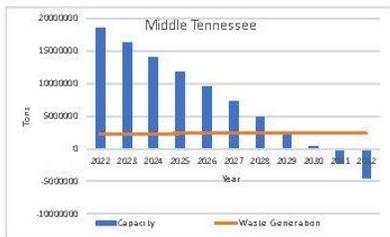
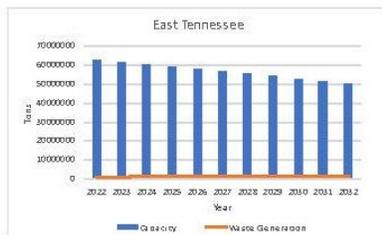
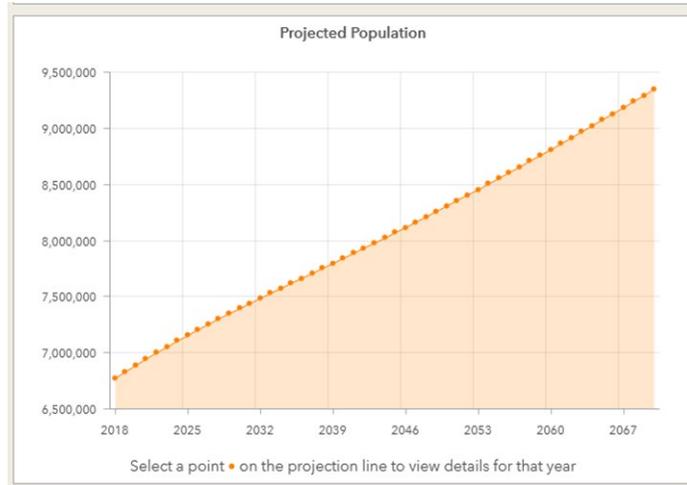


Figure 3

PUBLIC SAFETY

Landfills reduce the amount of waste that makes it into the environment, help to prevent disease transmission, and keep communities clean. However, landfills still have the potential for significant environmental and social impact. Landfills bring hazards such as odor, smoke, noise, bugs, and water supply contamination. Emissions from landfills [pose a threat to the health](#) of those who live and work around landfills.

INNOVATION

Though not widely known, Tennessee is among a select number of states pioneering innovative techniques and new technologies to help solve the dilemma of plastic waste and modernizing recycling infrastructure. Legislation supported and promoted by the Tennessee Chamber last year paved the way for manufacturers and companies across the state to adopt advanced chemical recycling technologies. Additionally, TDEC launched the [Tennessee Materials Marketplace](#), connecting businesses and providing tools for developing new market opportunities for recycling. Whereas traditional recycling typically chops up recycled waste, this process renders the recycled waste back to some of its original raw materials

There are many examples of this from great companies in the Volunteer State. For instance, the [Eastman Chemical Company](#) in Kingsport is unlocking new technologies that will allow for more efficient recycling of plastics. The company started with traditional recycling, a process that is effective and environmentally friendly. It has now designed molecular recycling technologies that expand the types of plastics that can be recycled and the types of products that can be created. This additional method will further divert waste from landfills.

BASF, with operations in Sparta and Chattanooga, has emerged as a global leader with its developments on advanced recycling technologies and its commitment to ending plastic waste. Additionally, [Chevron Phillips Chemical](#), which has operations in Knoxville, recently announced [its first successful commercial-scale production of polyethylene using recycled feedstock](#). Using advanced recycling technology, they are converting plastic waste into valuable liquids that can become new products and reduce the reliance on virgin raw materials and fossil fuels.

Acknowledgements: Special thanks to David Lipscomb University Professor Monica Sartain, and her CEE 491V Special Topics Class for assistance with data analysis.

Recommendations to Raise the Grade

- Permit additional landfills to avoid the additional transport costs to dispose of waste.
- Encourage a ready market for recycled materials in the state as the primary driver for recycling program success.
- Divert funds for specific objectives that will help communities reduce waste.

Resources:

- <https://www.serdc.org/resources/TN-SF-Waste-Study.pdf>
- <https://www.epa.gov/emergency-response-research/solid-waste>

- [University of Tennessee, Haslam College of Business, Boyd Center for Business & Economic Research, 2018 to 2070 Tennessee Population Projection](#)
- [TDEC SWM-Staff Memo “Remaining Life Survey Sanitary Landfills in Tennessee, Nov. 24, 2021](#)
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Stormwater: C+

Overview

22 Tennessee municipalities have implemented stormwater utility fees over the last two decades. These fees form a funding backbone to maintain stormwater pipes and drains, manage flooding and erosion issues, and increasingly create or support green infrastructure. However, water quality in the state remains an issue, as seen by prevalence of contaminants. Of the 46% of waterways that have been assessed, 56% of rivers and streams are impaired with at least one pollutant and 38% of the state's reservoir acreage is listed as impaired. Tennessee's population is growing, increasing the amount of impervious surface area (e.g., roads, parking lots) which catch and convey stormwater runoff after adding harmful chemicals. New rules, finalized in May 2022, will help regulate new development sites and encourage the utilization of green infrastructure, including bioswales and rain gardens.

Capacity and Future Need

The population of Tennessee is about 7 million people, having grown by 700,000 since the 2010 census, an increase of about 9%. Much of this growth has taken place in the middle and eastern portions of the state, which primarily rely on surface water for their drinking water sources. These sources are a direct result of stormwater runoff into lakes, rivers and manmade reservoirs. As land disturbance activities increase when new development has taken place, an emphasis on proper erosion prevention/sediment control (EPSC) measures has been taken. However, there are still issues with the increased amount of urbanization adding to the amount of impervious area.

The Tennessee Department of Environment and Conservation regulates and administers the Municipal Separate Storm Sewer (MS4) permit to cities over a certain population or density as well as larger installations such as universities and military bases in an effort to help reduce the amount of non-point source pollution entering the State's waterways. As of the composition of this report, 107 MS4's were regulated by TDEC. Of that number, 103 were audited since 2016 and 82 of those were found to be in compliance. Further, new post construction runoff rules are set to be finalized in May of 2022. These rules will help regulate stormwater that leaves the sites of new developments from both a quantity and quality standpoint, helping to encourage green infrastructure such as bioswales, rain gardens, etc.

Currently, local jurisdictions are tasked with the inspection and enforcement of rules and regulations that have come from the EPA's National Pollutant Discharge and Elimination System (NPDES) permit, as well as any state stormwater regulations, which is what the MS4 permit program helps to ensure. The tracking of construction activities and aquatic resource alterations is performed by TDEC and viewable through an online GIS database as well as a permit viewer. This data helps local jurisdictions with the inspections of these sites; however, with the sheer number of sites throughout the state, it has historically been a struggle to identify every single potentially polluting activity from a staffing standpoint, although some strides have been made. This staffing issue will continue to come into play as the new post-construction permit is implemented.

There are several "Qualifying Local Programs" (QLP) in Tennessee. A QLP is a municipality or county which has regulations that meet or exceed the requirements of the Tennessee Department

of Environment and Conservation (TDEC). Currently, there are seven jurisdictions which are part of this program, primarily east of Interstate 65, although one of those seven is the City of Knoxville, which is the third largest city in the state.

There are examples of early implementation throughout the state of green infrastructure. Design guidelines exist already which help engineers determine how to design for the new guidelines; Franklin, TN is one example of this. Tangible examples of GI exists in each of the three grand divisions of the state as well.

The State of Tennessee has 402 jurisdictions part of the National Flood Insurance Program (NFIP) out of a possible 410. Jurisdictions part of the NFIP are tasked with administering the federal and state guidelines for the program and are able to set regulations that are potentially stricter than these requirements. As of the writing of this report, all members of the program are in good standing. Also, 13 jurisdictions are part of the Community Rating System (CRS). This is a voluntary program which encourages floodplain management practices that exceed the minimum requirements of the NFIP. However, all of these jurisdictions are located in the middle and eastern parts of the state.

Condition, Operations/Maintenance, and Public Safety

A stormwater conveyance system comprises of multiple components, and usually means, “grey infrastructure.” Grey infrastructure is comprised of:

- Pipes, culverts or cross drains
- Inlets/catch basins (or colloquially “drains”)
- Open channels such as roadside ditches or artificial channels lined with concrete or rock

However, stormwater systems may also include more natural or semi-natural conveyances. This could include:

- “Unimproved channels,” “ditches,” etc, which are actually natural streams.
- Detention/Retention Basins and Ponds
- Green infrastructure such as bioswales or rain gardens

The maintenance responsibility of the first category largely falls with the public works departments of the cities and counties within Tennessee. This infrastructure is largely maintained, but it is primarily on a reactive basis. Further, the systems are relatively older, some being over a century old, and are not necessarily designed to current criteria or to current land uses. For example, much of the stormwater infrastructure in downtown Memphis was installed as a result of the yellow fever epidemics in the 1870’s and many of the larger conveyances are still around today. This is a similar situation in the older areas of other larger cities in Tennessee. .

The American Rescue Plan, passed in 2021 by the U.S. Congress, offers funding for upgrades to storm, sanitary and drinking water systems. Approximately \$1.35 billion was awarded to Tennessee for these uses, with approximately \$1 billion of it offered as non-competitive grants to counties and cities based on population. A pre-requisite of this funding is for jurisdictions to fill out a self assessment or “scorecard”. Two of the questions on this questionnaire were if the jurisdiction had a stormwater management plan and if it had a map of its storm sewers. According to the 46 responses as of May 2022, 9 did not have a plan or were unsure, and 5 did

not have or were unsure if they had a storm sewer map. However, many of the respondent communities (but not all) were moderate to large sized cities. Given that a significant portion of the statewide population lives outside of the largest cities and little is known about the rural infrastructure, this is something that will need to be improved upon..

Stormwater quality is also a key indicator of the system’s condition. Per the 2021 Tennessee's Clean Water Act Monitoring & Assessment Report, of the 46% of waterways that have been assessed within the state of Tennessee, about 56% of rivers and streams are impaired with at least one pollutant and are therefore on the state’s 303(d) list. About 38% of the state’s reservoir acreage is also listed as impaired. The Tennessee Department of Environment and Conservation has categorized the streams into categories which are listed in the table below and shown proportionately in the pie graph below.

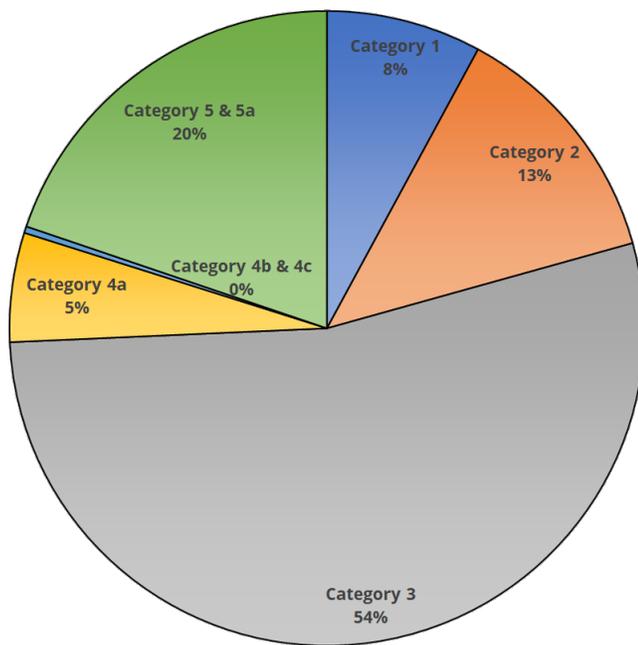


Figure 1: Assessment Status (TDEC)

Assessment Categories

Category	Condition
1	Fully supporting of all designated uses
2	Fully supporting of some designated uses, but not assessed for all uses
3	Not Assessed
4	4a: Impaired: TMDL is approved by EPA 4b: Impaired: TMDL is not required by EPA 4c: Impairment not caused by a pollutant
5	5: Impaired: TMDL needed 5a: Impaired: alternate plan in advance of TMDL accepted by EPA

Much of this impairment is due to the presence of pathogens and habitat alterations, primarily attributed to urbanization. Siltation is also a major factor of impairment, which could be caused by agriculture and construction site stormwater runoff. In West Tennessee, much of the streams have been straightened and head cutting has occurred as well as the sloughing of stream banks due to highly erosive soils.

There are efforts by agencies such as the West Tennessee River Basin Authority to help restore some of the channels and wetlands across this portion of the state. Other river basin authorities or watershed groups also exist to provide educational awareness of the impacts on rivers and streams, as well as to hopefully correct these issues.

Funding

Having a steady funding source is a key component to the repair/maintenance of stormwater infrastructure, as well the funding of staff and enforcement of regulations. Cities and counties are allowed to pass an ordinance to be able to charge a dedicated funding source known as a stormwater utility fee. This fee could be calculated based on the footprint of impervious area on a piece of property, although usually a minimum fee is charged. Some jurisdictions charge a flat rate for residential and commercial properties. The Municipal Advisory Technical Service (MTAS), a branch of the University of Tennessee at Knoxville will periodically request data from municipalities requesting stormwater utility fee information. The survey for 2004 recorded 31 cities' responses as to whether or not they charged a fee. Of the respondents, only 4 charged a fee and 8 were considering implementing a fee. An update of this survey done in 2021 by MTAS recorded responses from various MS4's. Of the respondents, 26 MS4's collected a fee while 29 did not, and of those 29, 6 were looking into it. Current stormwater fees range from \$6.03 per single family unit in Memphis, to \$9.00 per residence/\$108 per acre for other uses in Hamilton County to a flat rate of \$2.00 in Springfiled.

Other available funding sources are State Revolving Fund (SRF) loans as well as WIFIA loans, offered by the State of Tennessee and Environmental Protection Agency, respectively. Tennessee received \$25,855,000 for the Clean Water SRF and \$1,358,000 for Clean Water SFR Emerging contaminants. Although not "grant" programs, they are lower interest loans than those that would otherwise be available through the normal funding of projects. At the time of this report, the American Rescue Plan (ARP) was passed, with the intent of improving drinking, waste, and stormwater. All jurisdictions in Tennessee received an allotment of funds, but some municipalities may not choose to utilize these funds for stormwater, in lieu of improving drinking and wastewater conveyance system improvements.

Resilience

Within the past 15 years, there have been several flooding events throughout the state, including the 2010 Nashville floods, 2011 Mississippi River floods, and the 2020 Waverly Floods, causing billions of dollars worth of damage and dozens of fatalities statewide (27 in the 2010 floods in both Tennessee and Kentucky, 20 in the Waverly floods). In addition, there have been several localized events throughout the state, which could be contributed to increased urbanization or possibly changing weather patterns.

Innovation

There are measures by municipalities to correct some stormwater deficiencies. One example is of the City of Memphis when it comes to the current condition of its drainage network. Since 2014, the city has been completing a series of watershed-based drainage studies, in an attempt to create living hydrologic and hydraulic computer models of localized watersheds within the city limits. These studies are currently continuing to develop through the city's MSQ2 program (initialized in 2020), where projects are being prioritized based on need as well as completing condition assessments and mapping of the city's entire stormwater drainage system more accurately (potentially down to a sub-centimeter level), catching potential issues before they occur. Although the City of Memphis has a separate storm sewer system, its sanitary system has been under a consent decree to assess its sanitary system. This has been ongoing under the SARP10 program, and the assessment of the system should be completed in 2024 under this program.

Regarding the quality of streams within the state, the Urban Waters Report Card is being developed in conjunction with the University of Tennessee at Knoxville. This will be utilized in Tennessee's major cities/counties as a tool to help MS4's track the progress they are making in helping to improve water quality throughout their jurisdictions. Currently, it is going to be utilized by the larger municipalities in the state, but could be expanded to other cities/counties in the future and is a voluntary program.

Finally, many municipalities are undertaking comprehensive studies of their watersheds, primarily from a quantity standpoint but also to a quality standpoint from a lesser extent.

Recommendations

- Encourage municipalities to implement a dedicated stormwater utility fee for the purposes of improving drainage infrastructure
- Encourage jurisdictions to work towards CRS accreditation and increase staffing levels to allow to have dedicated floodplain managers
- Continue to evaluate the non-assessed streams in order to obtain better data regarding stormwater pollution in waterways.
- Continue to encourage jurisdictions to develop stormwater quality development guidelines
- Provide the resources for jurisdictions to both map and evaluate their existing stormwater infrastructure
- Plan for future growth and development

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Transit: D+

Executive Summary

Tennessee features transit service in every county, including bus services on fixed-routes, express buses, dial-a-ride transit vehicles, local shuttles, and paratransit service for patrons with qualifying disabilities. Transit ridership statewide was only up to 60% of pre-pandemic levels in April 2022, but Tennessee’s Department of Transportation found pronounced need for service during weeknights and weekends, when Tennesseans depending on transit are more likely to make essential trips. Residents with mobility options are choosing transit less and clogging roads with private vehicles. For those “choice riders” to return to transit, dedicated funding streams like regional sales taxes are necessary for significantly enhanced service in Tennessee’s four large urban areas – including rail transit and bus rapid transit using dedicated lanes on the state’s most congested corridors.

Condition

According to the Tennessee Department of Transportation’s 2022-2023 State Transportation Improvement Program, the State of Tennessee has 28 transit systems serving all 95 counties, including four large urban systems, eight small urban systems, 10 rural systems, one regional commuter transit system in Middle Tennessee, and local transit in five towns.³ Together these agencies provided 33.4 million trips in 2019. According to the Federal Highway Administration, as of 2020, there were 26,547 publicly owned buses in the State of Tennessee.¹⁸

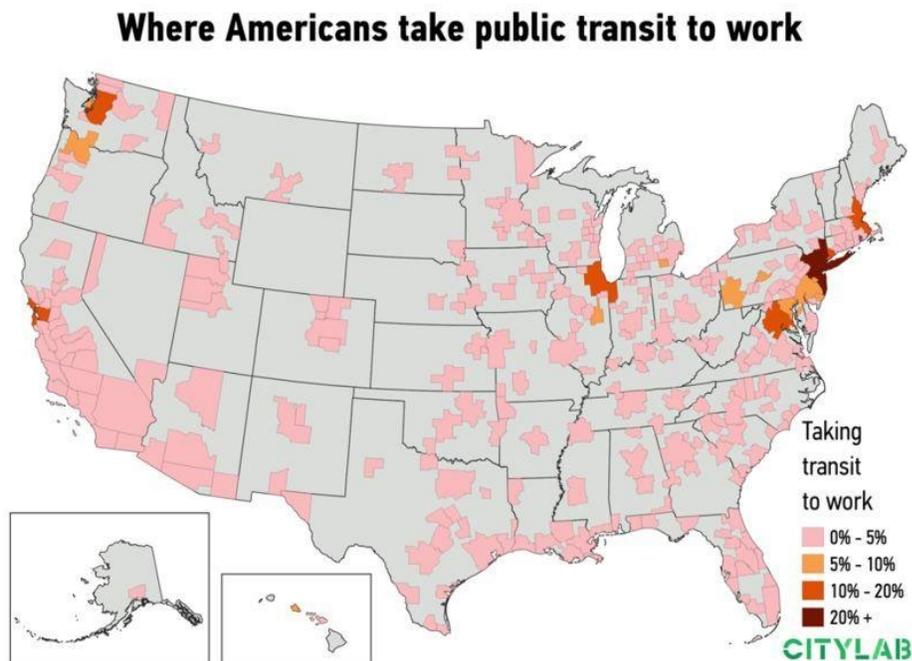


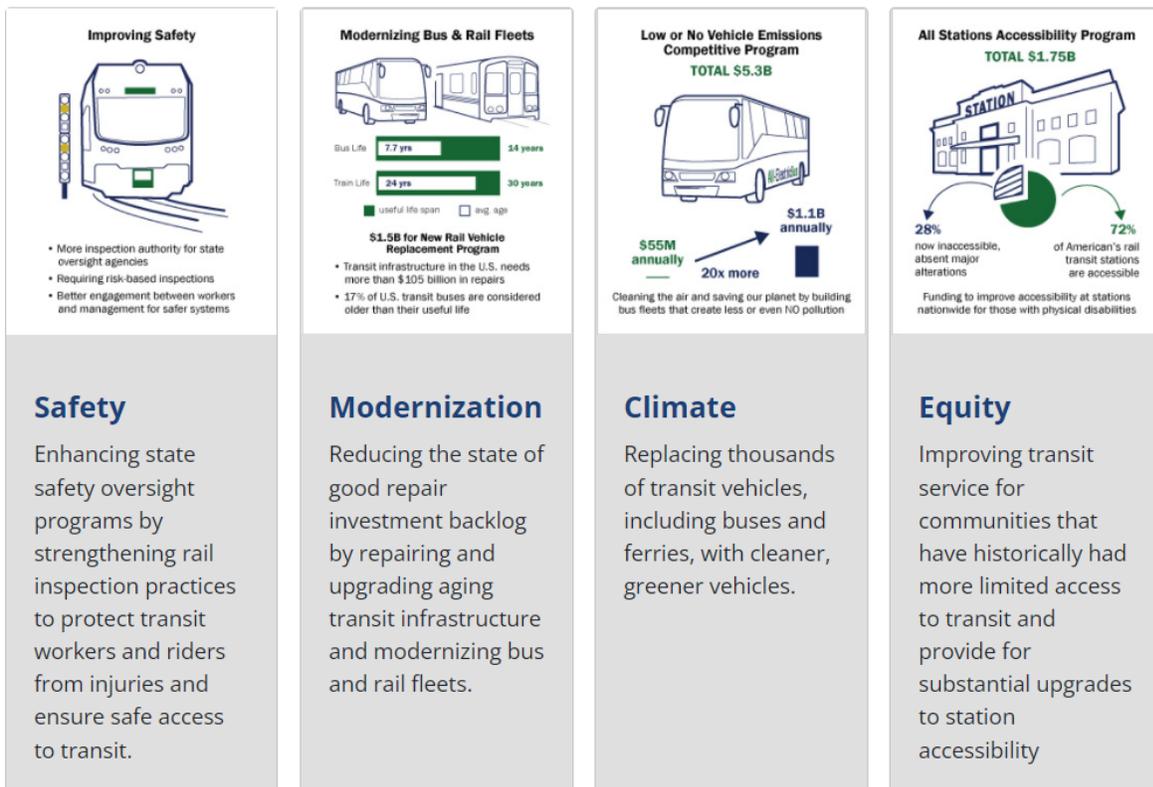
Figure 1. Public Transit Commuters in Large Cities.

Capacity

Transit ridership is low across the state. As shown in Figure 1, in the major metropolitan areas of Tennessee, namely Shelby and Davidson Counties, there is a five percent or less use of public transit as of 2019.⁹ It is important to note the severe impact that the COVID-19 Pandemic had on transit throughout the country. As of April 2022, transit ridership has recovered to about 60% of pre-pandemic levels throughout the nation.¹⁰

Funding and Future Needs

There have been major improvements in the funding for transit, both nationally and locally. The Bipartisan Infrastructure Law, also known as the Infrastructure Investment and Jobs Act (IIJA), authorizes up to \$108 billion for public transportation.¹¹ The State of Tennessee expects to receive 1.7 Billion in funding.¹¹ This is the largest investment in the nation’s history, and \$91 billion is guaranteed. The IIJA will advance public transportation in communities through four key priorities:



According to the TDOT Work Program, Tennessee’s transit funding in 2016 was \$47.7 million and increased to \$59.6 in 2022¹³, which is nearly a 25% increase. Funding of the TDOT work program comes from several sources including, highway user taxes, miscellaneous revenue, fund balance & reserves, bond authorization, transfer from general fund, ford general fund transfer, and the transportation equity fund.

In the STIP¹⁴ (State Transportation Improvement Program), federal funding for Tennessee for 2017-2020 included:

1. The Federal Surface Transportation Block Grant Program for small urban areas

2. The FAST (Fixing America’s Surface Transportation) Act established and funded new programs to support critical transportation to ease congestion and facilitate the movement of Freight on the Interstate System and other major roads. It’s an overarching act that disperses funds to many different programs and replaced many programs including Transportation Alternative Program which encompasses many smaller-scale transportation projects; however, it expired on September 30, 2021.

Transit systems across the state are making improvements to increase the quality and quantity of service. The Memphis Area Transit Authority has completed the design of a Bus Rapid Transit (BRT) corridor named the Innovation Corridor. The BRT line will encompass 8 miles and connect downtown Memphis to the University of Memphis area with 10-minute headways at peak times. The Innovation Corridor is projected to start service in 2026.⁴

Knoxville Area Transit (KAT), to meet the needs of the users, has embarked on a new project named KAT Reimagined. A potential redesign of service will consider the current routes within the system and examine many factors such as different areas of service, adjusted services during nights and weekends, and frequency of service.⁵

In Chattanooga, like KAT, there has been some rethinking of the transit system. In 2017 the Chattanooga Area Regional Transportation Authority worked with a consultant to develop the Choices Report, noting the current state of transit in Chattanooga, and determining the goals of the transit system along with the implementation of short-term and long-term goals.⁶

WeGo Public Transit, the agency serving Metropolitan Nashville & Davidson County, continues to implement elements of its nMotion Transit Plan and Better Bus program. Planned projects include a transit-oriented new corridor in the East Bank redevelopment area, development of Neighborhood Transit Centers, construction of a second downtown transit hub in the SoBro area, and eventual construction of a gold-standard BRT in the Murfreesboro Road corridor. Recently completed improvements include award-winning bus stops on the Nolensville Pike corridor, the installation of numerous new bus shelters across the Metro area, and the opening of the Hillsboro Transit Center in March of 2022. The center has covered bus bays, ticket vending machines, and other amenities.⁸

In 2022, NDOT (Nashville Department of Transportation and Multimodal Infrastructure) issued an updated WalknBike Plan¹⁵, with priority on sidewalk and bikeway projects that are close to transit stops. This will encourage more multimodal activity, as people will be able to get to and from transit on more ADA-accessible sidewalks and bikeways with nearly \$35 million per year for the next 3 years for this infrastructure.

However, there have also been some setbacks. In 2018, Nashville voters voted against a \$5.4 billion transit plan¹⁶ anchored by light rail with a tunnel. Since that time, WeGo Public Transit and NDOT have focused on the bus network and service improvements included in WeGo’s Better Bus program. Nevertheless, WeGo operates without a dedicated funding source, and no new proposal for dedicated funding has been introduced.

Public Safety

It is paramount to acknowledge safety and security regarding transit. The welfare of the public is very important. According to the National Transit Database, the total amount of collisions reported among all transit modes (light rail, bus) was reported to be 772 in 2021, a reduction from 862 in 2016.¹⁹ There was also a reduction in passenger injuries shifting from 987 in 2016 to 490 in 2021.¹⁹

Operation & Maintenance

According to the National Transit Database, in 2020, the State of Tennessee spent over 68 million to maintain transit facilities. Funding was spread to different areas including 8.1 million in station maintenance, 1.1 million to maintain maintenance facilities, over 28 million to maintain passenger vehicles that includes the floating and rolling stock used to provide revenue service for passengers and 3.7 million for fare collection equipment.¹⁹

Resilience

With significant funding from the Federal Transit Administration, there has been an uptick in transit funding, demonstrating the increased investment in non-single occupancy vehicle modes of transportation.

Innovation

The Federal Transit Administration's FY22 Low- and No-Emission and Bus and Bus Facilities programs will provide the State of Tennessee over 88 million dollars in funding. The funding breakdown includes 12 million for the Tennessee Department of Transportation to aid urban and rural transit agencies in the state to buy new buses and close to 200 demand response vehicles to replace older vehicles that reached their useful life. 76 million will be allocated to the Memphis Area Transit Authority to build a new operations and maintenance facility, designed to accommodate more than 300 vehicles, improving safety and the state of good repair for the bus fleet and purchase battery electric buses and charging equipment. Funded by the President's Bipartisan Infrastructure Law, the majority of funded projects will use zero-emissions technology, which reduces air pollution and helps meet the President's goal of net-zero emissions by 2050.¹⁷

Recommendations

For a significant change in the transit systems, it is recommended that Tennessee address access to transit systems, provide more funding for the systems, and integrate transit into all current and future roadway projects. In addition, technologies for transit such as Transit Signal Priority projects should be considered for improving reliability within the transit corridors. It is these efforts that will create substantive change within the Transit systems.

- Secure dedicated funding for transit in Tennessee's four large urban areas.
- Plan for dedicated right-of-way for transit service in the state's most congested corridors
- Increase access to transit in urban, suburban, and rural communities so that all Tennesseans have more and better transportation choices
- Increase education about navigating transit, including its benefits, and how to use it

- Adequately fund maintenance of transit vehicles and facilities to keep systems in a state of good repair and reduce life-cycle costs
- Include transit in state and local project development processes and metrics to track the performance of transportation systems
- Local, regional, and state government entities in urban areas should prioritize transit investments that can enhance sustainable land-use decisions

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Wastewater: C-

EXECUTIVE SUMMARY

Over the past 10 years, Tennessee’s wastewater infrastructure successfully supported a 9% population increase and substantial economic growth. However, capacity enhancements were accomplished at the expense of maintenance, as evidenced by combined & sanitary sewer overflows that result in sewer tap moratoriums. In 2019 there were 12 systems under a sewer tap moratorium due to overflows; in October 2022, there were moratoriums restricting new customers in some part of 45 municipalities. Overall, wastewater infrastructure owners report a \$5.9 billion, 13-year funding gap for needed capacity and to bring the systems back to a state of good repair. A one-time infusion of \$1.35 billion from the 2021 American Rescue Plan Act is going toward Tennessee’s water, wastewater, and stormwater projects. Additional support will be available from the Bipartisan Infrastructure Law passed last year. This will help supplement user fees, which average \$26 per month and are a necessary component of safe systems collecting, cleaning, and delivering plentiful water to a growing state.

CONDITION & CAPACITY

In wastewater collection and treatment systems, material condition and capacity are inter-related and almost indistinguishable.

Municipal Systems

Figure 1. Summary of TN Municipal and Decentralized Wastewater Systems' Surplus Capacities							
Grand Divisions	2018 Population	% Increase	Projected 2040 Population	Estimated 2017 Surplus Average Daily Flow [gpd]	Projected 2040 Surplus Average Daily Flow [gpd]	2018 Population Served	% 2018 Population Served
EAST	2,441,794	17.48%	2,868,735	170,547,597	115,045,267	1,213,670	49.70%
Rural	390,285	15.22%	449,694	-20,024,820	-27,747,990	98,778	25.31%
Urban	2,051,509	17.92%	2,419,041	190,572,417	142,793,257	1,114,892	54.34%
MIDDLE	2,766,101	36.63%	3,779,216	40,050,213	-91,654,738	1,685,187	60.92%
Rural	633,532	14.92%	728,084	-20,767,585	-33,059,345	140,681	22.21%
Urban	2,132,569	43.07%	3,051,132	60,817,798	-58,595,393	1,544,506	72.42%
WEST	1,575,656	7.69%	1,696,813	156,394,080	140,643,670	1,292,833	82.05%
Rural	471,705	7.18%	505,565	17,273,410	12,871,610	209,514	44.42%
Urban	1,103,951	7.91%	1,191,248	139,120,670	127,772,060	1,083,319	98.13%
TN Total	6,783,551	23.01%	8,344,764	366,991,890	164,034,199	4,191,690	61.79%

Based on TN H2O Report: Tennessee's Roadmap to Securing the Future of Our Water Resources

Collection Systems

Municipal wastewater (from a combination of residential, commercial, and industrial origin) is usually collected and conveyed in a combined sewer or sanitary sewer and treated at a centralized wastewater treatment plant. In older municipalities (Nashville, Chattanooga and

Clarksville in Tennessee) sanitary and stormwater sewers may be combined. The addition of stormwater dramatically augments flows during rain events enroute to the wastewater treatment plants.

Approximately 60% of Tennesseans are served by municipally owned wastewater collection systems and centralized treatment plant (POTWs). Effective management of Tennessee's public wastewater infrastructure (collection and treatment) is critical to the economic, public and environmental health of the State of Tennessee. The false notion maintained for many years that gravity sewers were "install and forget" has been dramatically dispelled. Combined and Sanitary Sewer Overflows (CSOs and SSOs) stemming from deferred maintenance and/or inadequate wastewater infrastructure remains the singular largest financial challenge to the municipal wastewater systems. Recurring CSOs and SSOs can result in restrictions of wastewater collection system growth by USEPA or state (Department of Environment and Conservation or Division of Water Resource) regulatory action. These "sewer moratoriums" can result in dramatic adverse impacts on communities' population or economic growth.

Unlike USEPA guidelines that permit "4 SSOs per 100 miles of sewer pipe per year", Tennessee regards any SSO or CSO as a violation of their permit and requires "self-reporting of violations" and considers cause for a moratorium any cite with three annual systemic overflows. In 2019 there were 12 systems under a sewer tap moratorium due to overflows; in October 2022, at the time of this report, there are moratoriums restricting new customers in some part of 45 municipalities. A moratorium on new sewer taps forces a redirect of funds toward system rehabilitation rather than expansion, and is one indication of the failure to maintain or upgrade systems.

The main causes of overflows are infiltration and inflow (I&I). I&I results from infiltration of groundwater into sewer lines as well as flow from stormwater into access points such as manholes during rain events. Overflows of the sewer system due to I&I may expose the public to hazardous pathogens or chemicals.

Besides counting self-reported SSOs and CSOs, actual measurement of additional I&I flow entering a wastewater treatment plant is a direct indication of collection system loss of integrity. From 2012 to 2015, two-thirds of all the municipal WWTP facilities treated 50% I&I rather than just wastewater. Additionally, 82% of Tennessee's municipal WWTPs exceeded their hydraulic design capacity in the event of a 2-year frequency, 24-hour duration storm (or approximately a 3.4-inch rain event.) Overall, Tennessee is not making much progress on municipal wastewater collection system integrity.

Treatment Systems

In Tennessee, all municipal systems discharge treated wastewater effluent into streams eventually finding their way to the Mississippi River and the Gulf of Mexico. Municipalities with stressed streams that also report a need for increased capacity are being forced to look at dramatically more technical treatment processes to compensate for the addition of more contaminants into receiving bodies. As alternatives to discharging, a number of systems are looking at the reuse of effluent, and/or shifting new development to decentralized wastewater systems generally using

land application instead of streams for the final treatment and destination of treated wastewater. Critical watersheds where this is the case include The Stones, Harpeth, Duck, and Little Pigeon Rivers. These technological challenges to meet water quality objectives coexist with Tennessee’s forecasted economic and population growth environment.

5-year sampling audits of all Tennessee streams continue to indicate an increasing number of streams listed as either “unavailable” for additional nutrient addition or are significantly degraded by nutrients. The United States Geological Survey developed versions of a computer model, SPARROW, that can be used to determine the contribution of these sources in each watershed or on a statewide basis. Use of the Tennessee Specific Model based on 2002 data indicates the following contributions for nitrogen and phosphorus at Memphis on the Mississippi River:

Figure 2 – Nitrogen and Phosphorus Contributions from the State of Tennessee

	WWTPs’ %	Fertilizer %	Manure %	Urban %	Natural %
Nitrogen	14.98	23.86	10.25	7.60	43.31
Phosphorus	10.61	32.56	4.60	5.93	46.30

Based on USGS SPARROW model projections by Vicki Steed, PE, TDEC-DWR, Water Resources Unit

Using the Midwest version of the SPARROW model which includes all states contribution to the Mississippi, Tennessee contributes 10.69% of nitrogen and 50% of phosphorus from states in the Mississippi watershed, relatively high percentages and potentially a liability for the State. WWTPs cannot solve the biological nutrient issue without cooperation of the agricultural and urban contributors. On the other hand, every successful operational modification to increase denitrification has resulted in lower WWTP operating costs and reduces the immediate downstream impacts of algae on water supply sources.

Onsite Systems

Standard Subsurface Disposal Systems (SSDSs) – commonly known as “septic systems” comprise the majority of the almost 4,000,000 systems with active permits today for individual homes from systems on their own property. While the exact number in operation is not known, SSDS and their alternative versions still provide service for probably 30% of Tennessee residents especially in some suburban and all rural areas. Like wastewater collection systems, these systems and not “install and forget” either; tanks have to be pumped at intervals even though the system is designed to limit the homeowners’ involvement with the unsanitary contents of the system.

Decentralized Systems

Decentralized systems fill the gap between municipal systems and onsite systems, especially when there is sufficient soil in the area for multiple homes but the acceptable soil is not distributed to each lot. Usually, small diameter systems are fed by grinder pumps or septic tank effluent pumps at each home and pump (or flow by gravity in some cases) to a simple WWTP. Decentralized treatment systems tends to be simpler than the larger municipal WWTPs and are

generally self-regulating. If well designed, they can discharge to surface waters under an NPDES permit. However, the majority of decentralized systems are designed for land application by drip tubing or spray systems.

The biggest challenges to this sector are:

- Controversies about design and soil standards;
- Resiliency of designs: the original systems were designed for short lifetimes anticipating that municipal systems became available to replace them;
- The variability of the quality required for installations around the state.
- The requirement to share the same soil scientists for the certification of land application disposal areas.

Onsite and decentralized systems by their nature are “just in time” service; the initial build out is on a demand basis or with limited additional or surplus capability. Based on 2017 estimates, only rural areas in east and middle Tennessee are lacking decentralized capacity. However, Tennessee’s population is growing quickly. Memphis, in particular, is attracting new residents with the addition of the Blue Oval Ford electric vehicle plant and satellite development northeast of the city. Small communities with municipal systems are already adding wastewater infrastructure capacity to meet residential and manufacturing design. Lagoon systems on small streams with severely restricted I&I situations will undoubtedly require significant repair and replacement of collection systems. Expansion and increased sophistication of treatment will be needed to meet receiving waters’ limited assimilation capacities. Studies to quantify the requirements are ongoing and will no doubt consume any existing wastewater facility surplus capabilities.

OPERATION & MAINTENANCE

Tennessee's population grew nearly 9% between 2010 and 2020. It is now the sixteenth most populous state in the union and only predicted to continue in growth and now boasts 7.05 million people, according to the 2020 Census. According to 2015 statistics, Tennessee has 253 publicly owned treatment plants (or POTWs), of which 174 treat 1 million gallons per day (MGD) or less. One MGD is capable of serving approximately 20,000 residents or less. The smaller POTWs collectively serve over 4 million people. Despite the trend toward urbanization the number of municipal plants remains relatively stable since a new stream discharge is not easily obtained.

The ownership and operational responsibilities of these facilities vary across Tennessee. In some cases, the systems are both owned and operated by municipalities or utility districts. In other cases, private companies or homeowner’s associations both own and operate the collection, treatment and disposal works. There are still a significant number of urban public customers, primarily in older/more rural areas of urban counties that remain on privately owned wastewater systems like SSDSs.

More than capacity, the largest issue facing stormwater and wastewater infrastructure managers is the lack of adequate personnel and equipment resources to check lines, clear blockages, and

repair failures. The State of Tennessee requires a person in charge of a water treatment plant, wastewater treatment plant, a water distribution system, or a wastewater collection system to have a certificate in a grade or higher than the grade of the treatment plant, distribution, or collection system he/she operates. There are currently approximately 2,670 employed operators for water and wastewater treatment plants in Tennessee. The annual mean wage for water and wastewater operators across the State is \$45,620. The Bureau of Labor Statistics predicts a 6 percent job growth for certified operators. However, various industry experts predict that up to 50 percent of the workforce will reach retirement age within the next ten years. Replacing retiring operators with people who have both the technical and soft skills needed will be a challenge that will have to be met to successfully operate the water and wastewater systems throughout the State.

FUNDING

Funding for wastewater infrastructure comes from four sources. First, sewer rates (normally calculated as an additional multiple of drinking water rates) are charged to customers for operational and maintenance costs, as well as debt service and depreciation. The average sewage rate for Tennesseans is \$26. Monthly charges for water service and sewer service include a fixed charge, a volumetric rate based on metered consumption, and an infrastructure replacement fee, which combined, is projected to grow by 4.2% this year.

Another regular source of revenue is municipal and utility district developer assessment fees, which are implemented for expansion of services. Additionally, loans or grants – or combinations of both – are provided by the federal government for wastewater system upgrades based on need. Finally, there are state-supported funds for special projects supporting economic development in the state.

In 2022, there was a one-time appropriation from the federal American Rescue Plan (ARP) Act, passed by Congress in response to the COVID-19 pandemic. The state used \$1.35 billion of the state's total allotment to support water, wastewater and stormwater infrastructure projects. TDEC is charged with administering the program and has issued its Water Infrastructure Investment Plan to outline the process. TDEC officials emphasized that the funding is a limited, one-time event and does not meet the total need for water, wastewater and stormwater infrastructure improvements in the state. However, this support will help previously unfunded projects to finally progress, and previously underreported projects may be captured.

FUTURE NEED

The State of Tennessee forecasts an overall growth in population of 23% between 2018 and 2040, reflecting a total population increase of 1.6 million. Of this, it is projected that 90% (1.4 million people) will locate in urban counties, and rural counties will see growth of 10% (or, approximately 200,000 people) over this 23-year period. With this growth comes a reasonable expectation that public water and wastewater services will be available to the growing public. At the same time, attention must be given to maintaining, repairing and replacing an aging infrastructure system. In consideration of this, forecasting the future infrastructure needs comes down to the dollars that must be invested to meet these needs, regardless of the funding source. The projected “Wastewater Repair & Replacement Project” investment statewide through 2040 is

a need of \$5.9 billion. (Figure 3). The projected “Wastewater Costs to Serve” investment, which reflects the investment needed to extend wastewater services to this growing population, for statewide population increases between 2018 and 2040 is a need of just under \$3 billion (Figure 4).

Figure 3. TN Repair & Replacement (R&R) Investment Needs

Developing State of TN Water/Wastewater REPAIR & REPLACEMENT (R&R) INVESTMENT Needs								
Planning Horizon (yrs)		23						
Repair & Rehab % Funding Needs		60%						
Geography	2018	2040	Total Pop Change (2018-2040)	Percent Change (2018-2040)	Water & Wastewater Project Funding Needs (per capita per year)	Water to Wastewater Project Ratio (%)	Water Projects R&R Funding Needs (Pop 2018 times Planning Horizon)	Wastewater Projects R&R Funding Needs (Pop 2018 times Planning Horizon)
Statewide	6,783,551	8,344,764	1,561,213	23%				
Urban Counties	5,288,029	6,661,421	1,373,392	26%				
Rural Counties	1,495,522	1,683,343	187,821	13%				
East	2,482,690	2,921,179	438,489	18%				
Urban Counties	2,051,309	2,419,041	367,732	18%	\$106	45%	\$1,351,092,046	\$1,651,334,722
Rural Counties	431,181	502,138	70,957	16%	\$103	85%	\$522,553,159	\$92,215,263
Middle	2,725,203	3,726,772	1,001,567	37%				
Urban Counties	2,132,369	3,051,132	918,763	43%	\$185	40%	\$2,182,571,261	\$3,273,856,892
Rural Counties	592,836	675,640	83,004	14%	\$154	80%	\$1,005,784,328	\$251,446,082
West	1,575,636	1,696,813	121,157	8%				
Urban Counties	1,103,951	1,191,248	87,297	8%	\$54	35%	\$287,163,903	\$533,304,391
Rural Counties	471,705	505,565	33,860	7%	\$50	75%	\$245,826,198	\$81,942,066
TOTAL							\$5,594,990,895	\$5,884,099,416

TOTAL R&R FUNDING Needs \$11,479,090,311

Source: TN H2O Report Tennessee’s Roadmap to Securing the Future of Our Water Resources Infrastructure Working Group (2018)

Figure 4. TN Water/Wastewater Total Investment Needs

Developing State of TN Water/Wastewater TOTAL INVESTMENT Needs (R&R plus Costs to Serve Population Growth)										
Household per capita		2.34								
Planning Horizon (yrs)		23								
Repair & Rehab % Funding Needs		60%								
Geography	2018	2040	Total Pop Change (2018-2040)	Percent Change (2018-2040)	Water Project Costs to Serve (per capita)	Water Project Costs to Serve (Pop Increase 2018-2040)	Water Projects R&R Funding Needs (Pop 2018 times Planning Horizon)	Wastewater Project Costs to Serve (per capita)	Wastewater Project Costs to Serve (Pop Increase 2018-2040)	Wastewater Projects R&R Funding Needs (Pop 2018 times Planning Horizon)
Statewide	6,783,551	8,344,764	1,561,213	23%						
Urban Counties	5,288,029	6,661,421	1,373,392	26%						
Rural Counties	1,495,522	1,683,343	187,821	13%						
East	2,482,690	2,921,179	438,489	18%						
Urban Counties	2,051,309	2,419,041	367,732	18%	\$430	\$157,937,472	\$1,351,092,046	\$1,220	\$448,417,980	\$1,651,334,722
Rural Counties	431,181	502,138	70,957	16%	\$419	\$29,705,592	\$522,553,159	\$3,150	\$223,486,614	\$92,215,263
Middle	2,725,203	3,726,772	1,001,567	37%						
Urban Counties	2,132,369	3,051,132	918,763	43%	\$919	\$844,427,010	\$2,182,571,261	\$2,009	\$1,845,624,516	\$3,273,856,892
Rural Counties	592,836	675,640	83,004	14%	\$762	\$63,266,482	\$1,005,784,328	\$3,150	\$261,429,921	\$251,446,082
West	1,575,636	1,696,813	121,157	8%						
Urban Counties	1,103,951	1,191,248	87,297	8%	\$406	\$35,468,702	\$287,163,903	\$1,154	\$100,703,169	\$533,304,391
Rural Counties	471,705	505,565	33,860	7%	\$380	\$12,862,262	\$245,826,198	\$2,756	\$93,314,961	\$81,942,066
TOTAL INVESTMENT NEEDS						\$1,143,667,520*	\$5,594,990,895**		\$2,972,977,160*	\$5,884,099,416**
									TOTAL \$15,595,734,992	

* TOTAL INVESTMENT NEEDS Costs to Serve projects include contributed capital by private sources
 ** Repair and Rehabilitation costs use TACIR per capita funding needs applied to Woods & Poole population increases times % applied to R&R times planning horizon (yrs)

Source: TN H2O Report Tennessee’s Roadmap to Securing the Future of Our Water Resources Infrastructure Working Group (2018)

Figure 5. TN Water/ Wastewater Total Funding Needs

Developing State of TN Water/Wastewater TOTAL FUNDING Needs					
	Water Project Costs to Serve (Pop Increase 2018-2040)	Water Projects R&R Funding Needs (Pop 2018 times Planning Horizon)	Wastewater Project Costs to Serve (Pop increase 2018-2040)	Wastewater Projects R&R Funding Needs (Pop 2018 times Planning Horizon)	TOTALS
TOTAL INVESTMENT NEEDS	\$1,143,667,520*	\$5,594,990,895**	\$2,972,977,160*	\$5,884,099,416**	\$15,595,734,992
Contributed Capital %	35%		45%		
TOTAL CONTRIBUTED CAPITAL	400,283,632		1,337,839,722		\$1,738,123,354
TOTAL FUNDING NEEDS	743,383,888	\$5,594,990,895**	1,635,137,438	\$5,884,099,416**	\$13,857,611,638

Note: **TOTAL FUNDING**Needs is defined as Total Investment Needs minus Contributed Capital
 Contributed Capital is only applied to "Costs to Serve" or growth related investment needs

Source: TN H2O Report Tennessee’s Roadmap to Securing the Future of Our Water Resources Infrastructure Working Group (2018)

PUBLIC SAFETY

Tennessee’s largest and most expensive fiscal challenge is also the source of its greatest threat to public safety: SSOs and CSOs. The implications of overflow events have been outlined in previous sections (Municipal Systems-Collection Systems.) While the State checks for completeness of construction stormwater plans, post construction stormwater plans are left to the local authorities. Meanwhile, global warming is exacerbating the magnitude and frequency of storms. This makes keeping stormwater and wastewater separated more difficult and the magnitude of failure greater. An often unappreciated fact is that without overflows, sewage could back up into residents’ basements.

There is great pressure to resolve water shortages in ecologically stressed watersheds by introducing potable and non-potable reuse. As important as this is economically, public health can absolute NOT BE COMPROMISED.

RESILIENCE & INNOVATION

Resilience comes from operating efficiently within the capabilities of the services required to protect public health and the environment. Most treatment design and construction standards in place were written in the 1970s. Updates should include emphasis on biological nutrient removal; flexibility of operational procedures and visibility for critical parameters; reducing carbon footprint; handling increasingly frequent and larger high flows events.

At the same time, medium size WWTPs designed and operated to meet stringent oxygen reducing, pathogen removal, nutrient removal, and industrial inorganic and organic contaminants due to small receiving streams are moving toward the One Water concept.

As examples, Franklin and Thompson Station on the Harpeth, Smyrna and Murfreesboro on the Stones, Spring Hill and Columbia in the Duck River Basin, and Pigeon Forge and Gatlinburg on the Little Pigeon have advanced wastewater treatment plants and are practicing non-potable

reuse. Franklin has a potable reuse pilot in place to produce drinking water quality water with low enough nitrogen to meet to discharge to the Harpeth River. Spring Hill is considering higher treatment of wastewater and an environmental buffer to augment their source water for the water treatment plant. On an average dry day in late summer and early fall, nearly 7 MGD of water is reused in an irrigation mode instead of being discharged to surface water.

RECOMMENDATIONS TO FURTHER RAISE THE GRADE

- **Collection System Integrity**
 - TDEC-DWR insist upon standardized state-wide municipal data collection to automatically calculate I&I metrics.
 - TDEC-DWR and Comptroller agree upon metrics for I&I and add I&I threshold as part of annual audit just like AWWA determined unaccounted for drinking water loss is reported.
 - A large issue exists with respect to whether repair or replacement of collection systems with its uncertainty is more cost effective than the expense of upgrading conveyance and treatment capacity to treat the excess I&I; the main tool TDEC-DWR has is the federal joint agency agreement to require life cycle cost analyses (LCCA) for federally funding projects. Progress has been made such that engineers and utilities expect to have to address I&I if they ask for capacity increases. The LCCA requirement should be reinforced and requirements for alternative allowances specified at the Preliminary Project Discussion.
Alternatives.
 - ARP funding provides a special opportunity to evaluate the benefit of large scale grants.
- **Decentralized and Onsite Support**
 - Resolve issues with land application and the State Rule 0400-40-06-.06 to remove ambiguity.
 - While digitization of soil maps and system designs has provided shorter time frames and public access to information; glitches still exist promoting discontent in the public; TDEC-DWR should improve State IT support for this program.
 - Improve the opportunity for qualified soil scientists to become certified to state if not national standards;
 - TDEC-DWR may have to be an incubator to improve career opportunities, recruiting potential students at state universities and providing paid internships or jobs; allow private soil scientists to participate in state training.
- **Biological Nutrient Removal**
 - Continue voluntary, funded and regulatory supported removal operational techniques. Advertise successes and operation cost savings.
 - As the State Statute requires, TDEC-DWR should find ways to incentivize land application and reuse.
- **Resilience**
 - Incorporate One Water perspective and Triple-Botton-Line evaluations in analyses for any projects with multifaced impacts; TDEC sponsor creation of templates by qualified engineering, science and economic expert consultants to provide guidance to engineering community.

- TDEC-DWR recommend to regulatory boards and the Comptroller those utilities and municipalities that should consider consolidation in regional endeavors.
- O&M: TDEC-DWR: Continue emphasis on asset management plans for wastewater utilities

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